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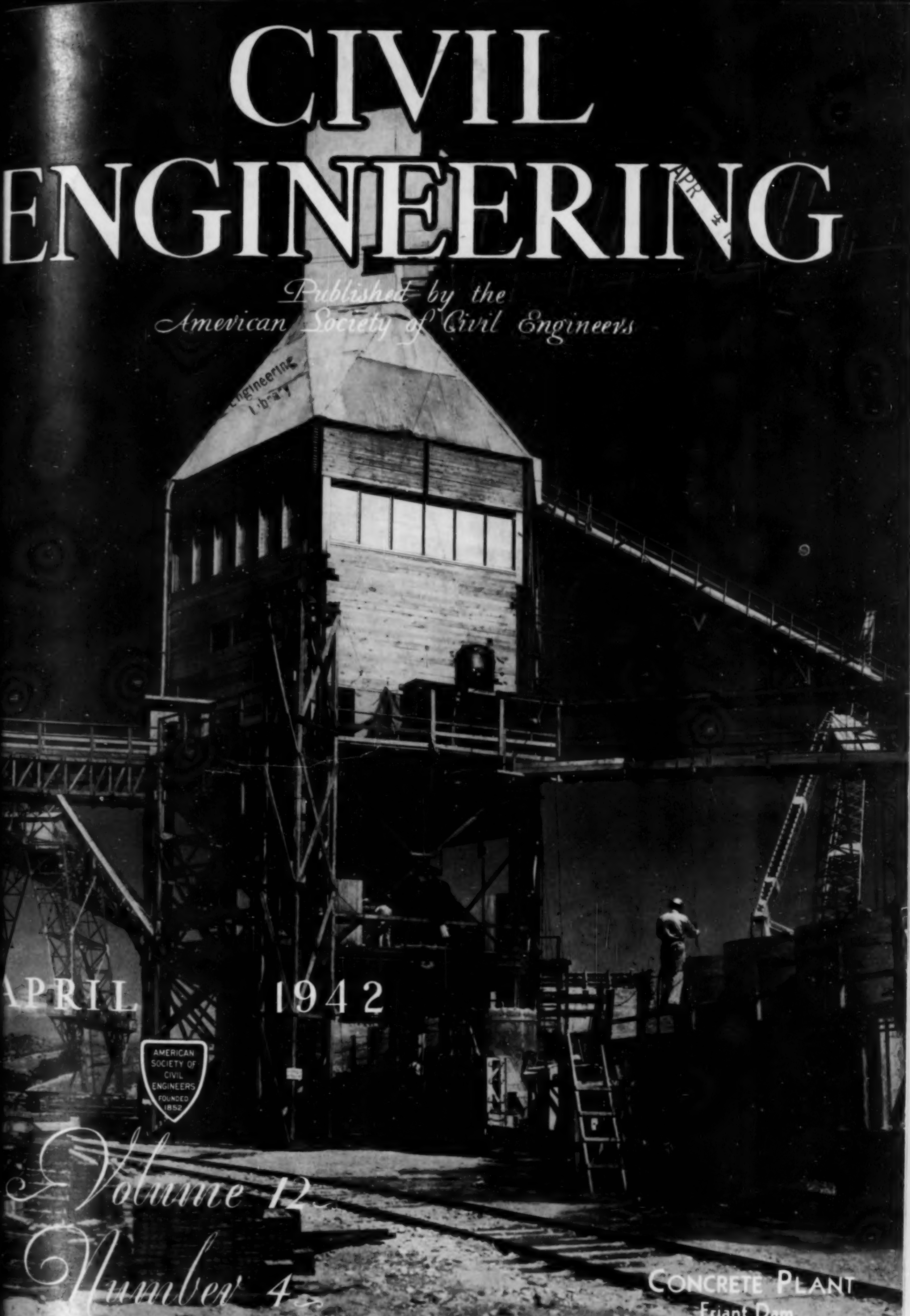

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CONCRETE PLANT
Friant Dam


UP A HAIR

Something to Think About

A Series of Reflective Comments Sponsored by the Committee on Publications

Functions of the Public Work Reserve

Its Philosophy and Its Operation, as Condensed from Paper Presented at the Society's Annual Meeting, January 21, 1942

By A. D. Morrell

National Director, Public Work Reserve, Federal Works Agency, Washington, D.C.

THE old exhortation, "in time of peace, prepare for war," has been reversed and restated many times—"in time of war, prepare for peace." Preparing for an enduring peace, a peace which will at least insure the social gains we have made these past ten years and prevent the dislocations which have traditionally followed every war—that is the job confronting us today. Moreover, that job is not inconsistent with an effective prosecution of the war effort. Planning for the post-war period, and continuous planning thereafter, must be as much a part of the war effort as the production of planes and tanks and guns, if the peace that is to follow is going to be worth anything.

War Affects All.~Many of the changes taking place all over the nation as a result of a vital war program are technological in character, but they affect the lives of every man, woman, and child. Of necessity, there has been a "gearing-up" of our production machinery to serve the needs of a people who do not choose, and we hope will never be required, to lower their standard of living. At the same time, it must meet the additional demands of the war program.

Great new factories have sprung up and those already in existence have been expanded. Towns have mushroomed into cities and "boom town" has become a national by-word. Location of war industries at strategic points has resulted not only in large-scale labor migration but has made necessary the planning and development of more or less permanent livable quarters and conditions for these workers. Viewed in its over-all aspect, unemployment has decreased markedly.

But the picture is not quite so rosy as it sounds. We hear a lot of "priority"; well, we are going to hear a lot more of the phrase "priority unemployment"—unemployment in big business and small business alike, caused by war diversion of materials and machines.

New Problems Emerge.~The war program has affected our lives in countless other ways. I make no claim to prescience when I say it will affect our lives far more drastically before it is over. The changes taking place in our body politic, in industry, in our economic system could be discounted if they were of a transitory character and merely affected our immediate future. But experience has taught, and sometimes painfully, that changes once made have a lasting impact upon our way of life.

It devolves upon us, therefore, to see to it that present changes in the national interest are adjusted to a peacetime economy which will be—not Utopian it is true—but just a little more secure, a little healthier, than before. These problems represent present hazards and potential dislocations which can be solved and which will be solved.

Public Works a Major Consideration.~I do not want to be accused of underestimating or ignoring the obvious problems in other fields. However, that part of the national economy known as public works certainly must receive major consideration in any over-all planning operations of the nation.

In such discussion we are prone to think in terms of stimulation or creation of employment. However, we should not allow our recent experiences to obscure the fact that the development of the nation, its cities, its highways, its natural resources, is after all the major justification of public work. Certainly there are a sufficient number of required operations to make unnecessary any reversion to activities whose sole purpose is to provide employment.

To Bridge the Gap.~It has been demonstrated that many months may elapse between the authorization of a major public works program and the actual employment of a large number of men on construction. Preliminary surveys must be made, studies and investigations carried on, land titles cleared, working plans and specifications prepared, financing arranged, contracts advertised and awarded, materials and equipment provided, and the personnel obtained. My own amazement is not at their slowness in getting into operation, or their inefficiency once under way, but at the magnitude of the accomplishments, considering the lack of widespread acceptance of the need for a planning operation.

To provide assistance to local governmental agencies in bridging the gap between the existence of needed public works and a program for their accomplishment, there was set up last summer, within the Federal Works Agency, the organization which I represent, the Public Work Reserve. It is under the Federal Works Agency; it receives counsel from the National Resources Planning Board, and operating funds from the Work Projects Administration. Briefly, the organization is set up as follows. A central headquarters unit has been established in Washington with a small staff of consultants, reviewers, and clerks. For purposes of operation, the country has been divided into four regions under Regional Field Representatives, who supervise the State Directors.

This organization has certain definite objectives:

1. A complete listing or inventory of public improvements, facilities, and new or expanded services which state and local governments feel to be desirable or necessary, together with such plans, estimates, or procedures as are available.
2. Assistance to local government units, where necessary, in the fullest possible preparation for such projects to the end that each project on the shelf will be completely planned and made available for immediate operation.
3. Encouragement of and assistance to local governments in the comprehensive development of programs based upon their budget limitations.
4. Assistance to the local government in conducting a continuing review program, to the end that it may be current at all times.

Federal projects, proposed for operation by the Federal agencies, and financed by them, will naturally be an important part of any nation-wide shelf of public work projects. Listing and developing a program of such projects, however, is the responsibility of the National Resources Planning Board. Since the program so prepared is available at all times for any future operation, such lists will not be duplicated in the Public Work Reserve inventory. Steps will be taken, however, to coordinate the Federal with the local programs.

Our field staff deals directly with state and local governmental units. The local administrations alone will have the controlling power, and that is just as it should be. The Public Work Reserve staff will act only in an advisory capacity. Actual operation of programs will devolve upon engineers attached to local governmental agencies and will open up new avenues for private and consulting engineers.

Objectives Are Related.—While the initial objective, that of inventory, will give the Reserve a nation-wide listing of all potential public work, and while the second objective, that of development of working plans, will make available an adequate reservoir of post-defense needs, yet the maximum benefit of any group of public works cannot be attained until the relative importance of each unit has been judged, the possibilities of its successful financing determined, and its effect on the economic and social life of the community studied. Because we believe this to be true, the third objective of the Reserve was established.

We encourage each agency to institute exhaustive and comprehensive planning. We ask them to evaluate in general terms the priority of each unit of work covered by a prospectus and the relationship of one unit to another. We will give them such assistance as appears advisable. We are asking the community to plan on the basis of its own budgetary limitations without inclusion of any except normal forms of Federal assistance.

This brings us to the reason for the last objective, the continuing review and revision of the inventory and programs. If and when an emergency period of unemployment occurs, it is assumed that a nation-wide effort, in some form, probably many forms, will be made to meet it. It will then be necessary to establish a new order of operation for the individual units in the program, not necessarily because the priority need has changed, but because it is better to have a slightly less necessary improvement which can be financed than to have none at all.

Continuity Ensured.—Conditions change and needs change with them. Even the most carefully prepared plan depends to some degree upon the ideas of the individuals who prepare it. Their interpretations and evaluations may be seriously at fault, as may be their plans for correction. For a program which is ill-conceived or which expresses the personal desires of the preparing body only, the need for continuing review is even more pronounced. After several "airings," a yearly review of such a program will ordinarily convince even the most stubborn council that certain things are impracticable and that certain others are necessary.

At all times the Public Work Reserve will emphasize:

1. That its function is to assist state or local authorities; but that the determination of the projects, the establishment of priorities and the fields to be covered, all are the responsibility of the local government.
2. That it is not the desire or intent to stimulate or expand public work needs or activities artificially, but to assist in establishing a well-planned nation-wide shelf of potential work, available for immediate operation as needs arise and, at the same time, to establish a procedure and form of assistance which will encourage the local government in its planning.

Starting Now.—Under present conditions many improvements may of necessity be suspended, many desired services delayed. Priorities of critical materials may make the construction of a desired facility impossible; unavailability of required personnel may result in indefinite postponement of desired services. At the same time, funds for the financing of these public works may be procurable.

Expenditures under the capital budget should be controlled so that such funds are not dissipated but are placed in reserve to meet the need when conditions change. For this reason our operation of today is an integral part of our plan for tomorrow.

As I indicated in the early part of my discussion, we in the Public Work Reserve are under no illusions as to the scope of the entire problem. We know that we have under consideration an important part of such a problem, however. We know that if we are able to stimulate a general acceptance by all local governments of the great value of continuing comprehensive planning and programing, so that the nation will always have an adequate volume of public work on the shelf of projects available for a readjustment program, our efforts will not have been in vain.

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Number 4

Pennsylvania Turnpike—One Year's Operation

Mechanics and Problems of Administering 160-Mile Dual Toll Highway

By Thomas J. Evans

Vice-Chairman, Pennsylvania Turnpike Commission, Harrisburg, Pa.

Once a job has been done, and well done, the construction engineer is wont to forget it, no matter how monumental the structure. But not so the owners and the maintenance department. They know their task is just beginning and will go on as long as the structure continues to serve its purpose. It is under the stress of use that the ability of the builder is put to the acid test. Does the work stand up? In the case of the Pennsylvania Turnpike the answer is emphatically "Yes," as Mr. Evans shows by data and records covering the first year's experience in operating this high-speed through route. This paper was originally presented before the Highway Division at the Society's Annual Meeting in January.

Because of the very boldness and audacity with which the project was conceived, the Pennsylvania Turnpike stands as an everlasting monument to the engineering skill of the country. Its first year of operation, as here described, attests its remarkable qualities. One naturally inquires as to the historical and geographical background which prompted construction of such a road.

As early as 1837, men of vision dreamed of a direct route over the Allegheny Mountains, connecting the industrial and agricultural sections of the Middle West with the commercial centers and seaports along the Atlantic coast, with Philadelphia as the logical eastern terminus. These early efforts to create a direct trans-Pennsylvania route had as their objective the construction of a railway line. They culminated in the creation of the South Penn Railroad Project. More than 5,000 miles of location surveys were run, a practicable line was established, and the Alleghenies were pierced with eight tunnels. Withdrawal of financial backing caused the project to be stopped in 1885. Although the idea of ultimately completing the project did not die, it was not until 1937 that the vision of the early pioneers was put to practical application—through an act of the Pennsylvania Legislature creating the Pennsylvania Turnpike Commission with power to finance and construct a highway along the line of the almost forgotten South Penn Railway.

Immediately the Commission took steps to explore and rediscover the old railway and tunnels. It spent almost three years in further surveys and lengthy studies in order to improve upon and shorten the old line and to establish engineering standards for an express highway through this rugged country. Just how well this work was done is attested by the fact that the completed road has maximum grades of 3% and a greatly improved curvature throughout its 160-mile length, in addition to being 28 miles shorter than the old route.

The Turnpike is by far the largest single highway job ever undertaken in this country. In fact, it compares with the major engineering projects of all time. It was built in 23 months under one of the fastest highway construction schedules the world has ever known. During this brief period 26,000,000 cu yd of earth and rock were blasted from cuts, transported, and carefully placed in fills; 300 bridges were built; 7 tunnels aggregating 7 miles in length were driven; and 46,000 tons of steel, 1,650,000 cu yd of concrete, and 4,300,000 sq yd of pavement were placed. A total of $25,000,000 worth of equipment and 180,000 men participated in the construction, and the project was completed at a cost of approximately $70,000,000, or an average of $440,000 per mile. Details have been given in separate articles dealing with the project by Herschel H. Allen, J. K. Knoerle, Samuel W. Marshall, and Charles M. Noble, in the January, March, June, and July 1940 issues of Civil Engineering.

It naturally follows that the maintenance and operation of a highway of the type and length of the Turnpike present many and varied problems. To effect efficient and economic results, all the duties connected

Snow-Removal Equipment in Action on the Turnpike

with administration and supervision have been centralized in the hands of the Commission's Vice-Chairman (the writer). Operation has been divided into three major units—roadway and building maintenance, tunnel operation, and fare collection, each of which will be considered briefly.

MAINTENANCE IS OF VITAL IMPORTANCE

To maintain this dual highway through a region that is perhaps the most rugged and mountainous east of the Mississippi River is no mean task. The job, under the direction of a chief maintenance engineer, with headquarters at Everett, Pa., is being carried on effectively by subdividing the road into six divisions. Each is under the control of an assistant who is responsible for safely maintaining the roadway and appurtenances, hiring required personnel, and supervising the use of equipment assigned to his division.

Obviously, owing to the geographic location, winter maintenance gives the most concern and expense. To conform as nearly as is humanly possible to the exacting requirements of the motoring public, every effort is directed toward providing the closest supervision to rapidly changing conditions, utilizing the most modern equipment. The major mobile equipment includes 51 auto trucks, of 2, 3, 5, and 7-ton capacity; 90 reversible and one-way snow plows; 36 cinder spreaders of the tailgate hopper type; and 6 overhead snow loaders with bulldozer and digging bucket.

Vigilance must be maintained throughout the winter. Our system provides for a constant patrol of bad areas, the observance of temperature and barometric fluctuations to determine the approach of a storm, and an immediate warning to the maintenance assistant in the division concerned, who organizes the required crew for cindering or snow removal.

Cindering of icy locations within each division is being done with untreated cinders, using hopper-type spreaders. The crew comprises a truck driver and two laborers who see that the cinders are fed through the spreader attached to the rear of the truck. This mechanism can be adjusted to spread various widths but ordinarily is set to cover the 24 ft of the turnpike, thus making it possible to serve an entire lane in one operation.

Snow is plowed by units of three to five trucks running in tandem at 200 to 300-ft intervals. They plow outward from the medial or center dividing strip toward the shoulder area. When this shoulder area has been filled, the overhead loaders put the snow in trucks, thus providing space for additional snow falls. Ice cutting equipment attached to trucks has proved a valuable aid in baring the pavement after plowing operations are completed.

During the winter of 1940–1941 cindering operations consumed approximately 30,000 tons of untreated material at an expenditure of nearly $80,000, including application. Snow removal required an expenditure of nearly $30,000.

Summer maintenance comprises the usual highway procedure. Some of the items include mud jacking; shoulder stabilization; painting of buildings, equipment, and traffic lines; and cleaning and repairing of drainage ditches and drains. Landscape planting and maintenance are important requirements for beautification.

TUNNEL OPERATION—A KEY FEATURE

In order to establish what seems like a "water-level route" through the Alleghenies and to reduce grades to one-third those on previous highways, the Turnpike was driven under the mountain ridges at seven different points. The resulting tunnels are probably the outstanding feature of the entire route. The finished job provides a tunnel lined with a thick casing of concrete reinforced with steel, brilliantly illuminated 24 hours a day. A unique system of mercury lamps not only floods the roadway with light but also patterns the side walls with a soft blue glow, creating the effect of a medieval cathedral.

Ventilation for the tunnels is provided by 26 fans, which are constructed to the same dimensions but are operated at varying speeds depending on the requirements at each point. Tunnels are provided with 4 fans each, two at each portal. The single exception is Rays Hill, which is so short that only two fans at one portal are necessary.

Capacities and pressures provided at the various tunnels are as follows:

Tunnel	Volume per Fan Cu Ft per Min	Total Pressure In. of Water
Laurel Hill	200,000	1.4
Allegheny	260,000	1.8
Rays Hill	310,000	3.9
Sideling Hill	300,000	2.2
Tuscarora	230,000	1.5
Kittatinny	204,000	1.0
Blue Mountain	190,000	1.0

Four fans operating full speed will deliver approximately 1,200,000 cu ft of air per min through the air tunnel parallel to and above the vehicular tunnel. The device determining the fan speed and corresponding volume of air to be furnished at any given time is the carbon monoxide detector. This registers and records graphically the amount present in the atmosphere of each tunnel. Generally the permissible limit is 1.5 parts of CO in 10,000 parts of air, although 4 parts is considered by the U.S. Bureau of Mines as safe operating practice.

Every possible safety precaution is exercised to minimize the hazard to the motoring public while passing through the tunnels. In the event of a fire or a wreck in a tunnel, a specially designed fire-crash truck and three specially trained attendants, fully equipped, are always on hand.

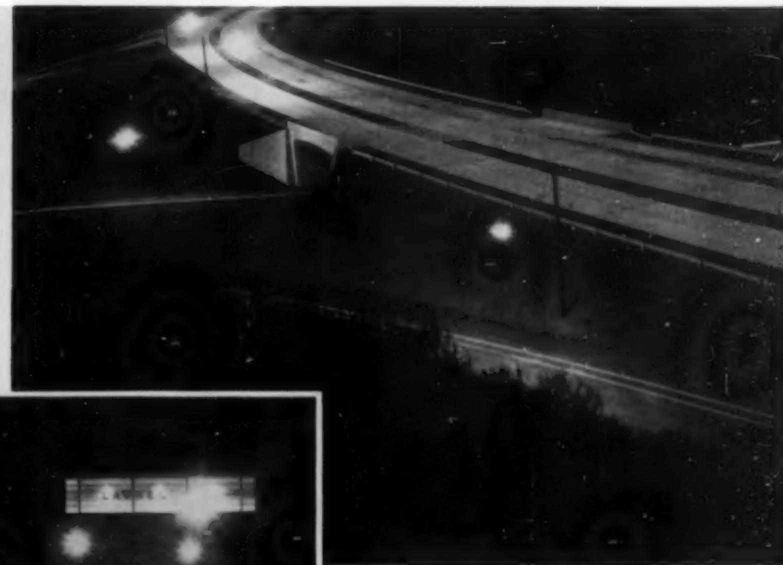
Illumination is provided by 250-w mercury vapor lamps, approximately 155 lamps per mile of tunnel, placed in rows alternately over each of the two lanes on about $37^1/_2$-ft centers. A total of 1,060 of these lamps in all the tunnels burn continuously 24 hours a day. Sodium vapor lamps are used for illuminating the approaches and interchanges. In all, 324 of these are in operation, 172 at tunnel approaches and 152 at interchanges.

FARES, PLEASE

Toll collection, because of its direct association with finances, is probably the most vital of all the three units of operation. Through this medium is obtained the major part of the income required to pay for operation and maintenance, to provide for bond interest, and to ensure the ultimate retirement of bonds outstanding.

To effect this end, and in addition to handle traffic flow efficiently between public highways and the Turnpike, ten interchanges have been established at strategic points. These are easily accessible from main highway routes but are so designed that only at the termini of the road, that is, at Carlisle on the east and at Irwin on the west, are the toll booths on the Turnpike proper. The remaining eight (intermediate) stations are set several hundred feet to one side. In construction, the toll booths are as modern as the highway itself. They combine gleaming sky-blue porcelain with aluminum trim

LOOKING INTO TUSCARORA MOUNTAIN TUNNEL FROM THE OUTSIDE, AT NIGHT



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NIGHT LIGHTING MAKES TURNPIKE CURVE AND ACCESS HIGHWAYS STAND OUT

© Westinghouse

LEAVING BRILLIANTLY LIGHTED LAUREL HILL TUNNEL

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EMERGING FROM A TUNNEL PORTAL

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DRIVERS STOP AT WELL-LIGHTED TOLL BOOTHS UPON ENTERING AND LEAVING THE TURNPIKE

On the Pennsylvania Turnpike by Night and by Day

An Unexpected Visitor Uses the Turnpike

Bomber Being Rolled Onto the Turnpike After an Emergency Landing

Passing Under a Grade Separation—Not Much Room to Spare

Then Comes the Take-Off, on a Straight and Level Section

and sea-green glass, which reflects the heat of summer but retains the warmth within during the winter.

Automatic mechanical equipment of modern design is provided to properly record and check the flow of traffic through each lane. Smartly uniformed attendants, specially trained, are on duty the full twenty-four hours of each day. They issue to drivers entering the Turnpike properly classified tickets for their vehicles and collect the correct fare from those departing. The staff required to efficiently handle traffic varies, of course, with the intensity of the traffic itself, particularly during summer months and holiday periods. But the normal force comprises 52 officer collectors in addition to a superintendent of fares and a clerk-stenographer. The gathering of reports of each day's transactions together with the cash intake is made by uniformed tellers, properly armed, who convey the money to the regular depository banks, and the reports to the commission's central office.

MAIN TOLL BOOTH AT CARLISLE, PA.—EAST END OF TURNPIKE

During the first year of operation, or the period from October 1, 1940, to and including September 30, 1941, the foregoing procedure had successfully handled transactions on 2,473,817 patron vehicles at something more than one dollar per vehicle, a total of $2,729,928.46 in tolls. This was somewhat in excess of expectations based on the traffic engineers' estimate of $2,670,000 for the first year. It definitely proves the financial stability of the project. Further it is of interest that revenues for the period beyond the first year, or for the months of October, November, and December 1941, would indicate that the percentage of increase forecast and anticipated for the second year will also be exceeded.

UP-TO-DATE FEATURES AND FACILITIES

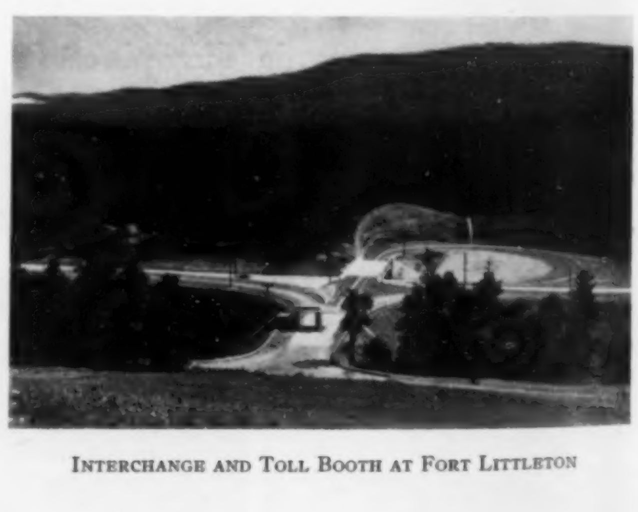
For the comfort and convenience of Turnpike patrons who may wish to stop occasionally for refreshment and service, there is provided, through an arrangement with the Standard Oil Company of Pennsylvania, eleven service station–restaurants at carefully selected locations. The largest and busiest of these is "Midway" near Bedford. In addition to all the various facilities for automobiles and trucks, it has complete dining room and lunch bar service under the management of Howard Johnson, Inc. Sleeping quarters for truckers are also available at this point and arrangements have recently been completed to start work on "sleep-over" facilities for tourists. Service at the remaining ten stations along the Turnpike is fashioned much like that at Midway except, of course, on a smaller scale.

The Turnpike Division of the Pennsylvania Motor Police has headquarters on the Turnpike near Midway Station. It has rendered invaluable service to Turnpike patrons and established for itself an enviable record for assistance rendered to disabled motorists particularly during the first winter of operation. Since that time, in an effort to relieve the police for their full-time duty of patroling and enforcing the state motor laws and rules of the Commission, a system of towing and repair service has been instituted. To this end outside garages along the Turnpike have been assigned districts for operation and patrol with equipment and trained personnel. They are authorized to make emergency repairs on the road to any disabled vehicle or provide towing off the Turnpike if major repairs are necessary. The system is still in the experimental stage but so far it has given indications of supplying a very necessary service to patrons of the road.

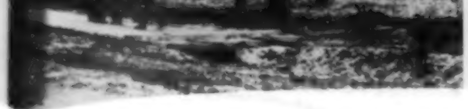
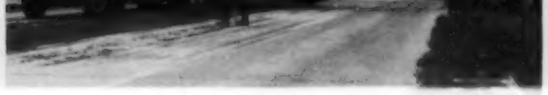
Communication facilities are necessarily a vital factor in the efficient operation of any project. From the outset the Commission realized the importance of this element on a route as long as the Turnpike. It therefore made provision for the most modern means of communication—radio. At an expenditure of approximately $325,000 there is now in successful operation a system of two-way communication in ultra high radio frequency. This establishes almost instant contact with fixed stations at 33 points and also with 26 mobile units, including cars operated by the motor police and supervisory heads. The operating benefits alone to be had through this means are tremendous, especially in connection with emergencies arising during severe weather. Then again the benefits to the police in the apprehension of criminals, especially during the present national emergency, certainly justify the time spent in research and the cost in dollars of the communication system.

The military significance of this modern express highway, always claimed in theory to be tremendous, is right now proving itself. Almost daily during the past several months the facilities of the road have been used by the several branches of the service in the movement of equipment and men. By reason of its high design standards, motorized units are assured of swift, uninterrupted movement for 160 miles. Of nearly equal importance, the sinews of war in the form of raw materials and finished goods, so vitally important in the defense requirements today, are being rushed in the shortest time possible in great volume from the industrial sections of Pittsburgh and the Middle West to points along the Atlantic coast.

We feel, and justly so, that the Pennsylvania Turnpike for the first time in the history of motor transportation in America has permitted the full potentialities of the modern automobile to be realized. It has done so by providing a limited-access, non-stop, express highway through the rugged and dread Allegheny Mountains. Thus it has brought into realization the vision and dream of early pioneers by truly serving the nation in peace and in war.



INTERCHANGE AND TOLL BOOTH AT FORT LITTLETON


Long-Range Engineering Planning for Chicago

By W. W. DeBerard, M. Am. Soc. C.E.
City Engineer, Chicago, Ill.

A MUNICIPAL engineer must know not only where his city stands but also whither it is pointing. In this article the City Engineer of Chicago examines the huge engineering enterprises under his charge and cites examples of projects existing, under way, and planned, together constituting a sort of futurama. Half a billion dollars worth of construction soon to be under way and two billion envisioned as an early goal—that is some measure of the interest of this survey, originally presented by Mr. DeBerard before the Society's Fall Meeting in Chicago on October 15, 1941.

THE progress of civilization has permitted concentrations of population in restricted areas until we are hived up in metropolitan regions almost beyond reason. However, that is the situation. Our modern production plant of the machine age, which is the main reason for getting us so close together, requires manning and servicing. What the ratio of this production plant to the servicing facilities is, some one may in time work out for the competitive use of one chamber of commerce against another. That the service facilities which are necessary and desirable in Chicago bear a high ratio to industrial values, measure them as you will, goes without saying; otherwise the industries would not stay here.

A brief outline is submitted of the more important engineering facilities we have built up in Chicago to meet the demands imposed by the necessities of the 3,400,000 people who live and work here, producing not only for the great Middle West but for the markets of the world. That the engineer is responsible for what has been built, what is now under way, and what is planned for the future, is self-evident.

On a number of projects I want to elaborate a bit. But I will not have space to touch on waterways, piers, ports and river control; on street traffic control, in which Chicago has long been a pioneer; on truck, bus, and local transit problems; or last, on the problems incident to the terminus of 29 railroads, bringing here more high-speed traffic than goes to any other place in the world.

To start with the Chicago airport—this is unique in its dual system of runways, which have a total length of 9.4 miles. The average runway length is 5,600 ft, the longest, 7,226 ft. The dual runway system insures a landing capacity that will make the airport useful long after all other single-runway airports have reached their capacity. Its runway lighting system will be the most complete and advanced of any airport in the world, consisting of 440 flush-type runway lights, 4 flood lights, and a complete traffic control signal system—all operated by remote control from one point in the control tower. The new system will afford a dual air traffic control, radio control, and signal-light control.

Plans are now being prepared for a building to cost $1,200,000 outside of the estimated $400,000 additional for ramps and underpasses. The one thing needed to make the airport complete is a high-speed traffic system between the airport and the Loop, in the nature of a subway or a high-speed elevated highway, estimated to cost $8,000,000.

In the fields of activity that are the direct concern of the city's Department of Subways and Superhighways, long-range improvement programs totaling $580,000,000 are contemplated. Of this vast sum $63,000,000 is for subways for mass transportation. This project is essentially completed. In addition comprehensive plans for superhighway work have been prepared, and acquisition of right of way for the first route, the $41,000,000 project, is actually in progress. The total subway program, with future extensions planned for three construction stages, totals $280,000,000. The superhighway program, embracing comprehensive construction of 62 miles of grade-separated safety highways, includes a terminal quadrangle around the central business district and involves an estimated expenditure of $205,000,000. Modernization of Chicago's privately owned mass transportation facilities, which is nearing the stage of actual physical work, involves an additional expenditure of $102,000,000, to be defrayed by private financing.

Chicago possesses one of the greatest park systems in the world. Of the 35 miles of lake frontage within the city limits, 28 miles is park frontage. Much of the 7,000-acre ownership is in major parks, the lake-front parks being preeminent. The boulevard system is 156 miles in length and includes Chicago's only superhighway, that along the lake front from Lincoln Park to

Belmont Avenue Grade Separation Involves a Clover-Leaf Design

Old Two-Way System with Fixed Center Curb, at Lief Eriksen and 27th Street

New System Using Movable Curb, Gives Three of Four Lanes in One Direction

OLD AND NEW IN EXPRESS HIGHWAY TRAFFIC CONTROL

Jackson Park. Park buildings include 100 field houses, which serve as recreational and community centers. Park improvements alone are valued at $180,000,000.

What is being built now? Under the current budgets, curtailed to allow precedence of national defense needs, new construction is limited to the most vital work. The major projects are under way. The Outer Drive in Lincoln Park is scheduled for completion in 1942. This will segregate fast-moving through traffic from recreational areas and will provide safety, beauty, convenience for thousands daily, both in mass transportation carriers and in private automobiles. Extension of protection work along the lake front, including the creation of beaches, rearrangement of quarrystone stepped slopes, and landscaping along the park margins is under way and should continue. The new plan not only creates a gigantic playground along the entire lake front but also eliminates the costly rebuilding of bulkheads and jetties to withstand the continual pound of the waves.

CONSTRUCTION PROPOSED FOR POST-WAR PERIOD

The future program, to be undertaken when national economy permits, is dependent only on the will of Chicago to retain its importance. In the post-defense period to come, the morale of the citizenry, the opportunity and right of the people to enjoy cultural and recreational advantages, the pride of Chicagoans in maintaining and developing their great metropolitan center will demand a wise and well-balanced expansion and improvement program in their parks.

The 7,000 acres in the present parks must be expanded to 35,000 acres to measure up to present-day accepted standards of one acre for each 100 of population. This plan requires first a land acquisition cost of $70,000,000, and next a construction development of $300,000,000. The rebuilding of the lake front in order to attain a bathing beach from one city limit to the other must be pushed to early completion. This accomplishment will be the last link in making Chicago a great summer resort. This again—in hydraulic work, construction, and engineering—means an expenditure of $35,000,000.

Transportation needs alone constitute a major problem. Chicago is and must remain a metropolis. It is therefore necessary that new extensions, to the north Outer Drive as well as to the south Outer Drive, be developed. This again, in the creation of land, in paving, and in the building of grade-separation structures, means an outlay of at least $60,000,000.

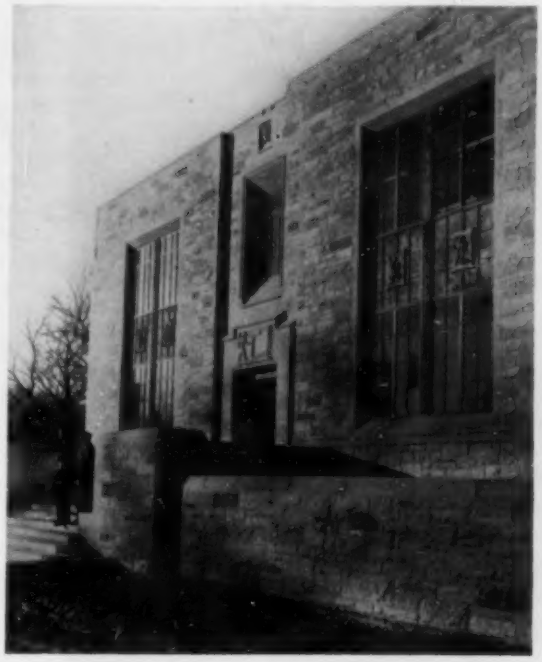
These larger concepts of future needs do not include the immediate pressing needs for the modernization and rehabilitation of some of the existing park facilities, such as outmoded field houses, inadequate filtering plants for swimming pools, improvements of existing pavements and utility systems—a $35,000,000 program. The park program will become a factor of major importance in the problem of readjusting labor in the after-war period. It is a potential $500,000,000 program.

Largely on the theory that it is cheaper to subsidize low-rent housing than to continue to pay the excessive governmental and other costs of maintaining slums, Chicagoans have been instrumental in bringing five federal housing projects into being. The largest cares for 6,706 in 1,662 dwelling units, averaging $5,045 per unit. Two other projects are in the development stage. The aggregate cost of the seven will be $34,000,000, averaging $5,771 per unit for the 5,910 units. The aim of the Chicago Housing Authority is to devise plans for the elimination of all substandard housing conditions in Chicago. That this is an ambitious program may be judged from the fact that 76,000 low-income families will still need decent low-rent homes after the above noted 5,910 units are filled. As this latter number is only 7.8%, the final cost will run to something like $380,000,000.

Like most metropolitan areas in this country, the section around Chicago is rapidly developing both within suburban towns and in unincorporated places. Cook County, through its highway department, is now taking steps to develop a system of express highways throughout the county outside of Chicago. Such highways should allow for the free flow of through traffic without local interference, and should be grade separated throughout, both at highway and railroad crossings, with frequent points of access. These highways will have divided pavements built on wide 200 to 300-ft rights of way. No access to adjoining properties is planned. The right of way is now being acquired with the thought that the land itself can be acquired and the plans for the construction completed at such time as material and labor may be available to proceed with the construction. Since 1914 Cook County has invested $95,000,000 in the improvement of its highway system.

The future construction program, covering the next fifteen years, as adopted by the County Board in 1940, calls for an $83,000,000 express highway system outside Chicago in addition to the elimination of grade crossings on the existing system at a cost of $18,000,000.

Protection of the public water supply of Chicago and suburbs against sewage contamination and the disposal of all sewage is provided by the Sanitary District of Chicago, an independent municipal corporation em-



New Technological Institute of Northwestern University—Civil Engineering Wing

bracing 63 cities and villages with a present population of 4 million, plus industries producing wastes equivalent to a population of two million. All sewage is diverted away from Lake Michigan by the Chicago and Calumet rivers, which were reversed and now discharge to the Mississippi drainage basin through 56 miles of canals built as a part of the original system of disposal by dilution.

The disposal system consists of 173.3 miles of intercepting sewers and 11 pumping stations which receive more than 99% of the sewage originating in the 443-sq mile area served and convey it to treatment works. Of the latter, three are equipped to give an average flow of 786 mgd complete treatment by the activated sludge process, and one plant has the capacity to treat 472 mgd in Imhoff tanks without secondary treatment. Work now under construction includes extensions of the Racine Avenue Pumping Station and the Southwest Sewage Treatment Works.

Principal items of future work to be constructed as soon as the defense program and finances will permit are the further expansion of the Southwest Works and construction of the South Side Intercepting Sewers. Past expenditures are $100,000,000 for the original dilution project and $167,000,000 for treatment, which is presently to be augmented by $12,000,000 for work now under way and $20,000,000 for additional collection facilities in the distant future.

Operation and maintenance of the water supply system call for the solution of ever-existing engineering problems to keep its 12 pumping stations, 6 intake cribs, and 60 miles of tunnels reliable, efficient, and of sufficient capacity to meet the peak demands of the present and future. This valuable utility now serves the city and 37 suburban communities with a total population of more than 3,750,000. It has annual earnings of $13,500,000, an appraised value of $140,000,000, an outstanding indebtedness of $42,000,000, and a notably low water rate of 51 cents net per 1,000 cu ft. It is financially in a favorable position to carry out a needed major expansion program for filtration plants to supply the entire city and an extension to the many suburbs which are still dependent on an unsatisfactory and uncertain supply of hard ground waters from deep wells.

Julia C. Lathrop Homes, for 925 Low-Income Families, Are Operated by Chicago Housing Authority

Cost of Over $5,000,000 Borne by the Federal Government

Major improvements to the distribution system are now under way or contemplated at four pumping stations. The work involves an expenditure of $4,000,000, three quarters of which is now in process.

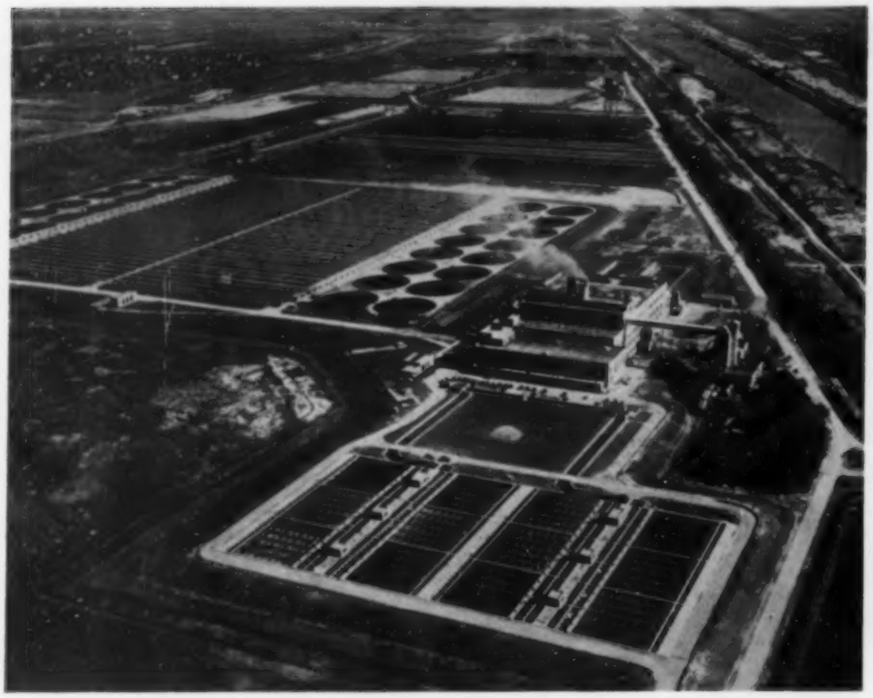
The city now has under construction and more than half completed a 320-mgd filtration plant for the South District which, it is estimated, will cost $24,000,000. Studies and tentative plans are under way for two more such plants, one for the Central District and the other for the North District. It is estimated that the rated capacity for the Central District plant should be 520 mgd and the project cost $25,000,000; the rated capacity of the North District plant should be 300 mgd and the initial cost $15,000,000.

Expenditures now estimated at $80,000,000 for (1) metering, (2) construction of filtration plants, and (3) extension of distribution facilities to serve the entire metropolitan area needing and wanting this improved service, could easily approach the $100,000,000 mark. These projects readily could be organized as a part of the extensively needed Public Works Reserve, which our national economy will call for to meet the expected post-war unemployment problem.

Planning of future filter plants for Chicago, especially in the congested central district and along the lake front, holds an unusual opportunity for the water works engineer to cooperate with (1) the city planner who wants to break up the monotony of a checkerboard street system; (2) the housing expert who wants blighted areas demolished and open areas established around which to build modern housing projects; and (3) park and school officials who wish more space for public recreation and playground areas.

BRIDGES, A VITAL SERVICE, MUST BE MAINTAINED

Chicago owes its existence to Lake Michigan and the Chicago River, as these were the means by which the early settlers reached and occupied this area. The Chicago and Calumet rivers, having a total length of over 35 miles within the city limits, divide this region into several sections. The logical way of bringing these sections together was by means of bridges. In 1892 a folding lift bridge was built at Canal Street and in 1894 a Scherzer rolling-lift bridge was built at Van Buren Street. By 1900 the city's engineers had developed a trunnion bascule bridge of the type now commonly referred to as the Chicago trunnion bascule, which has been widely copied throughout the world. We now have 63 movable bridges and over 40 fixed bridges across the Chicago and Calumet rivers, representing an investment valuation of $80,000,000. In addition the city owns



Chicago Aerial Survey Company

SOUTHWESTERN SEWAGE TREATMENT PLANT, LARGEST IN THE WORLD, IS ADJACENT TO THE CHICAGO DRAINAGE CANAL

numerous viaducts representing an investment cost of $25,000,000. A new three-truss bascule bridge and viaduct, estimated to cost $3,000,000, are being constructed at State Street over the main channel of the Chicago River. This has been described in Mr. Becker's paper in the March issue of CIVIL ENGINEERING. Other projects involving an additional expenditure of $8,000,000 are on the program for the next few years.

During the past 10 years, owing to economic conditions it has been necessary to rehabilitate ten of the older structures to extend their life until they can be replaced with new ones, thus postponing $15,000,000 of construction work. In spite of this, at least two movable bridges will have to be replaced each year and others constructed at new locations in conjunction with superhighway developments, which coupled with fixed-bridge and viaduct reconstruction will entail an annual expenditure of at least $5,000,000. Considering the extensive bridge services which the average Chicagoan receives, it is indeed remarkable that the cost to him is slightly in excess of one dollar per year.

AN INVENTORY OF INDUSTRIAL DEVELOPMENTS

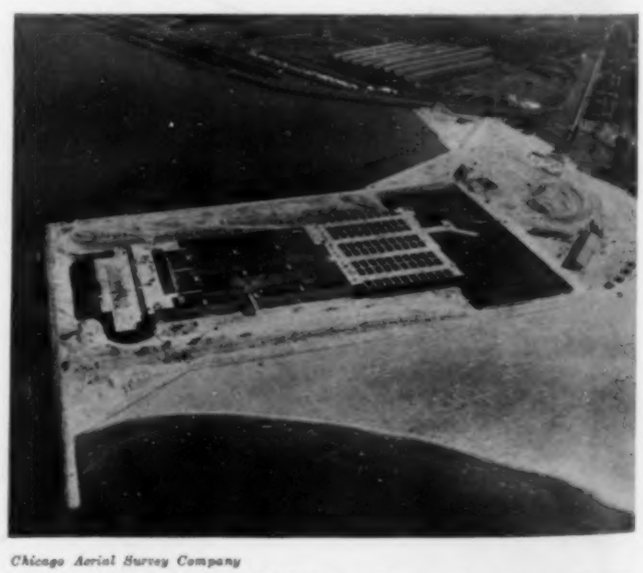
The engineering facilities that have been described present a potential total, so far as figures are available, of more than two billion dollars. In order to get at least a rough inventory of our industrial plant, I went to the active Chicago Association of Commerce. E. P. Querl, industrial manager, is responsible for the following figures:

Cook County continues to bear the distinction of being the largest county in the nation based on the value of its manufactured products. It is the only county in the nation which produces manufactured products in excess of three billion dollars annually. The greatest industry in the Chicago area is iron and steel manufacturing, in the volume of which it ranks within 19% of Pittsburgh. Its second industry is machinery manufacturing, the third, meat packing, then petroleum refining, chemicals, textiles, furniture, and railroad cars.

Chicago's place in the present national defense picture is basically satisfactory, although not so colorful as some cities, because we cannot build battleships and we have no military production of airplanes. Since the beginning of the emergency up to December 5, 1941, a total of 1,240 concerns in the Chicago area have received 5,523 defense contracts totaling $1,233,412,000. One reason for the placing of so many defense contracts here is that the 9,000 manufacturing plants in the area are largely engaged in the metal trades. This condition also invites a great number of subcontracts, which it is estimated have totaled $400,000,000.

Including the 30 outstanding concerns which Mr. Querl named, 500 manufacturing concerns in the Chicago area have been involved in the construction of new plants or in expansion of present ones, representing a total capital investment of $189,000,000. This activity was preceded in 1940 by investments of $126,000,000 for similar purposes, thus giving a grand total of $315,000,000 in recent plant construction activities. These figures add a goodly sum to the recent industrial development, but we still have too few statistics to venture a ratio of the service facilities to the industry values.

I wish to credit the following persons who so generously gave of their time to outline these various projects for my use: Ralph H. Burke, M. Am. Soc. C.E., chief engineer, Chicago Park District; Miss Elizabeth Wood, director, Chicago Housing Authority; Walter Wright, superintendent, Bureau of Parks, Recreation and Aviation; Philip Harrington, M. Am. Soc. C.E., commissioner, Subways and Superhighways; George A. Quinlan, M. Am. Soc. C.E., superintendent, Cook County Highways; William H. Trinkaus, M. Am. Soc. C.E., chief engineer, The Sanitary District of Chicago; Arthur E. Gorman, M. Am. Soc. C.E., assistant city engineer; O. B. Carlisle, engineer of water works design; and Stephen H. Michuda, engineer of bridges.



Chicago Aerial Survey Company

SOUTH DISTRICT'S 320,000,000-GAL WATER FILTRATION PLANT

Army Cantonment Built in Sub-Zero Weather

Many Different Types of Facilities Provided on Carefully Planned Schedule

By Daniel B. Niederlander

Vice-President and General Manager, The John W. Cowper Company, Inc., Buffalo, N.Y.

Building an army cantonment under the stress of the war emergency calls for smooth-working cooperation between the Office of the Quartermaster General, the Constructing Quartermaster, the architect-engineer, and the contractor. Describing this project before the House Appropriations Committee, Maj. Gen. Brehon B. Somervell, Chief, Construction Division, said that it is "an especially fine example of good planning and execution." It had to be, in the face of sub-zero weather, heavy snowfall, and a schedule demanding peak production from the time the first tree was felled until the barracks were filled with soldiers. This description of the construction of a large Army camp was presented by Mr. Niederlander before the Construction Division at the Society's Annual Meeting in New York.

Few sections of the United States are subject to more severe winter conditions than northern New York State, where the cantonment construction here described took place. Most of the work was done between October 1940 and March 1941, although road surfacing was postponed until warmer weather.

The War Department, on October 17, 1940, announced that a joint contract had been awarded to the John W. Cowper Company, Inc., of Buffalo, N.Y., and Senior and Palmer, Inc., of New York, for the construction of the cantonment. Actual field operations commenced on October 18, 1940, and formal notice to proceed was dated October 21. The completion date specified in the contract was March 1, 1941.

Previously, both contractors had filed their qualifications with the proper authorities in the War and Navy Departments. Early in October they were called in for an interview with the Construction Advisory Board. This board most thoroughly investigated their financial and technical ability to perform the proposed work, especially their experience and capability in getting results under the most adverse winter conditions.

In the final negotiations a "Description and Estimate" was presented to the contractors, which indicated that the proposed work consisted of approximately 700 buildings of frame construction on concrete foundations at an estimated cost of \$5,075,445, and general utilities at an estimated cost of \$560,450, or a total of \$5,635,995. After submitting answers to a questionnaire and further discussing the difficulties due to location and weather conditions, the contractors were awarded a cost-plus-a-fixed-fee contract with a stipulation that not more than 20% of the work could be sublet. On completion of the work, it was determined that 15.02% of the total cost was for sublet contracts.

The final cost of the project was approximately \$16,000,000, of which \$5,000,000 was spent for utilities. This total cost was 8% under the estimated cost established by the architect-engineer after all requirements of the War Department were taken into consideration, and approximately one-quarter of 1% in excess of the funds actually authorized for construction by formal War Department Construction Authorizations, which are based on the Department's own estimates.

Previous to the award of the construction contract, an engineer-architect contract had been awarded to the engineering firm of William S. Lozier, Inc., of Rochester, N.Y. The engineers arrived at the site about a week before the contractors, and at the end of this time had a well-established office in a vacant CCC Camp on the Military Reservation, and had placed about 15 survey parties in the field.

The layout finally adopted which was the third submitted, located the buildings in a 1,000-acre area, of which 850 acres had to be cleared of scrub pine, oak, and brush. The topography was such that 1,250,000 cu yd of earth had to be moved for proper grading of the site. The topsoil was a fine sandy loam and the subsoil was all sand, of a character later found suitable for all masonry mortar. Some was used to adjust the fineness modulus of the concrete aggregate.

On October 18, 1940, a day after the award was announced, the contractors started clearing in the area tentatively selected for the first layout, and a few days later started grading operations with several power-scraper units. The contractors were immediately aware that the prime requirement for the successful operation of the project was the construction of roads in advance of all building operations. They were fortunate in accomplishing this purpose and the success of the project was greatly influenced by this performance. It was finally necessary to construct 68 miles of roads of all types and 800,000 sq yd of stoned areas, all of which required 540,000 tons of crushed stone.

For all principal roads a two-layer stone base was placed. Each layer was 6 in. deep after rolling, and this base gave excellent service throughout the construction period and was surfaced in the spring and summer of 1941. Grading of the site, work on roads, and placing of the road base were carried on with great speed, at first with a single 10-hour shift; then, as soon as portable flood lights could be secured, it was stepped up to two 10-hour shifts, and finally, as the necessary personnel became available, to three 8-hour shifts. This work was carried on seven days a week in an effort to get as much done as possible before the ground became frozen. Most of the work at this time was being done by 16 power scrapers, 44 bulldozers, and 10 power graders. During a cold spell early in December 1940, the ground froze quite deep, making it necessary to supplement the grading

Summer View of Nearly Completed Camp

CONCRETE FOOTINGS FOR BUILDINGS WERE CURED UNDER HEATED TENTS

A RAILROAD SPUR, COMPLETED WITHOUT DELAY IN WINTER WEATHER, ALTHOUGH EXCAVATION WAS DIFFICULT AND EARTH WAS FROZEN TO A CONSIDERABLE DEPTH

CONCRETE BATCHING PLANT PROTECTED BY A TEMPORARY SHELTER

TYPICAL OFFICERS' QUARTERS OF SEMI-PERMANENT CONSTRUCTION

PORTABLE STONE CRUSHER SUPPLIED MATERIAL FOR ROAD CONSTRUCTION

WINTER CONDITIONS ADD TO THE DIFFICULTIES OF CONSTRUCTION

equipment with 4 shovels, 60 trucks, 6 draglines, and 5 rooters.

The amount of work performed by this equipment was as follows: site grading, 1,250,000 cu yd; road grading, 705,000 cu yd; stone crushing, 570,000 tons; asphalt paving, 324,700 sq yd; penetration asphalt placing, 85,000 sq yd; and clearing areas of stones, 800,000 sq yd. Also constructed by the contractors, during the summer of 1941, was 14 miles of concrete pavement 24 ft wide, in accordance with New York State Highway standards.

There were no railroad facilities available at the site and all materials were hauled from team tracks about three miles from the site. As many as 75 cars per day were handled and not one dollar was paid in demurage. Right of way for the railroad to service the cantonment was not secured until February 1941. The distance from the St. Lawrence Division tracks of the New York Central Railroad to the site was 3.5 miles. The excavation was most difficult as some soft limestone and glacial drift were encountered and the earth was frozen to a considerable depth.

Ten wells of the gravel packed type, with 3-ft seamless steel casing and slotted bronze screens, were sunk to depths up to 150 ft; these produce 3,000,000 gal daily. Each well has an electrically driven turbine pump with a capacity of 100 to 400 gal per min. The distribution system consists of 175,000 lin ft of cast-iron mains 6 to 16 in. in diameter, and 75,000 lin ft of house services, all with 6 ft of cover. In addition, two 500,000-gal elevated steel tanks were built and 252 hydrants installed.

In all 130,000 lin ft of sanitary, and 13,000 lin ft of storm sewers were laid. Sizes were from 8 to 30 in. in diameter, laid at depths from 8 to 26 ft. Because of the sandy soil, all banks were sloped and no sheeting was used. The excavation for sewer and water lines involved 443,000 cu yd and was handled by a fleet of 12 drag shovels, 2 cranes, 6 draglines, and several trenching machines. Backfilling was done with bulldozers and bullgraders, except for the very deep trenches, where the clamshells and draglines used for excavating were also used for backfilling.

Another part of the project was a sewage disposal plant with a capacity of 3,000,000 gal daily and two pumping stations of 350,000-gal daily capacity. A high-tension line of the Northern New York Power Company crossed the site, and a 9,000-kva substation was built by the contractors. Distribution was generally overhead, consisting of 387,000 lin ft of primary circuits, 272 transformers, and 300,000 lin ft of secondary distribution.

To expedite construction, the entire project was divided into classes of work rather than into a certain number of areas. According to this arrangement, all the foundation work was carried on in sequence by one organization under the charge of a field superintendent. Concrete for the foundations was purchased from a commercial concrete concern which had constructed a temporary plant at a central location on the site. From this, concrete could be quickly delivered at the various building sites. It was placed by hand, or by buckets handled by tractor cranes as required.

Foundation work was at all times kept in advance of the carpentry. All lumber was hauled from the railroad siding, and that which did not require fabrication was delivered directly to the building sites. All framing lumber was brought to a yard parallel to the main road through the camp, and was fabricated as required at one of 14 sawmills. Following the foundation crew came a carpenter framing crew, in charge of a field superintendent, which proceeded with the framing of the buildings only. This organization was in turn followed by another, responsible for enclosing the buildings and laying the subfloors. Next came the roofing crew, and then another crew to install the doors and windows. At this stage the buildings were turned over to subcontractors for plumbing, heating, and electrical work, after which the general contractor again took them over and installed the finished floors, partitions, and insulation. The last crew installed shelving and equipment where such were required. Painting was completed whenever the temperature was higher than 40 F. It should be noted that the factor which controlled the speed of operations at all times was the delivery of materials, and this largely determined the number of men put on the job at any one time. The Government purchased the heating units and about 90% of the lumber and millwork. The contractors and subcontractors purchased all the other materials.

SETTING OF FOUNDATION FORMS WAS HAMPERED BY FROZEN GROUND, SNOW, AND LOW TEMPERATURES

Buildings were generally constructed from standard War Department plans modified to meet site and other local conditions. Buildings with wood floors were supported on small concrete piers carried 5 ft below grade on account of the deep frost line. Buildings and parts of buildings with concrete floors, such as barracks, had continuous concrete wall foundations. The contractors prepared plans and obtained approval for using a reinforced concrete "grade beam" construction to replace foundation walls. These beams, 8 in. wide and 24 in. deep, were at ground level, with V-shaped bottoms to resist frost upheaval; they spanned between the piers, which went well below the frost line. This design expedited construction and saved over $150,000 in labor and materials.

The first week in December 1940, after the contractors had been operating six weeks, the temperature fell to 34 F below zero and there was a heavy snowfall. From then on it was just one long winter and frost did not leave the ground until April 15. To continue foundation excavation it was necessary to use pneumatic pavement breakers and clay spades. To protect concrete piers, one or two kerosene lanterns were placed in the excavation beside the pier and the whole was covered with canvas and hay. The protection of the concrete wall construction required the erection of a wood frame covered with canvas over the entire building area. Oil-burning salamanders of all types were used inside this enclosure. After the buildings that were to have concrete floors were erected, it was necessary to remove about 2 ft of frost before the floors could be poured. All known thawing methods were used, but proved ineffective. Finally the frozen earth was removed with pneumatic tools and replaced with unfrozen earth generally taken from the sewer excavation. On the whole project only about 25 piers were of questionable strength and they were re-

FIRE STATION AND EQUIPMENT—READY FOR ACTION DAY AND NIGHT IN ALL WEATHER

placed. In the protective work 600,000 sq ft of canvas, 450 oil-burning salamanders, 6,800 lanterns, and 230,000 gal of fuel oil were used.

Frost penetrated to a maximum depth of 42 in. This, together with the problem of servicing, operating, and repairing over 100 items of heavy equipment, presented a real problem to the utilities section. Ground was either thawed by burning waste material or was broken up with rooters, with as many as three caterpillar-type tractors of the heaviest type hooked on for power. A special frost-breaking machine was imported but proved useless under the conditions. The employment of 8,000 men under severe winter conditions without a day lost was one of the most unusual features of this project.

The additional cost of winter operations was estimated by the contractors to be $885,000 which represents about $5^1/_2\%$ of the total cost of the work.

Construction problems in cantonment construction are comparatively simple and are within the scope of everyday experience. However, because of the short time allotted for the performance of a very large volume of work, it became a management problem of the first order. The procurement and distribution of large quantities of materials and the securing and efficient employment of a large labor force, together with the assembling and operation of an unusual amount of equipment, were the principal problems, but there were also problems not ordinarily encountered which had to be dealt with promptly and effectively. Among these was the establishment and operation of departments of police, fire, highways, commissary, and first aid. These were necessary because there was no military post at the site and all these services became the obligation of the contractors. An experienced police chief was engaged together with about 25 uniformed deputy sheriffs, recommended by the local sheriff. This force was expanded to about 100 police and watchmen and functioned as a regular police department under the general direction of the Assistant Project Manager.

Snow was removed from the roads with a fleet of nine plows and loaders of different types, and also with power graders released from other work as required. This equipment was ready for operation any hour of the day or night. The night crew was housed in a special bunkhouse and the equipment was stored in a heated building or kept warmed up if stored outside. It was also necessary to keep parking areas cleared to avoid road congestion, and to keep all access roads cleared and sanded. Operations were at their peak in January and February, and prompt snow removal was one of the essential requirements for continuous operation.

Another contributing factor to assure continuous work was the operation of a commissary where hot meals were served at noon time in 12 mess halls, also a cafeteria for office workers and a dining room for the administrative staff. Two mess halls were open for coffee and sandwiches 24 hours a day; in the other mess halls this service was continuous during the day shift only. The contractors felt that it was absolutely necessary to provide this service and to give the men the privilege, under the control of the foreman, to get a cup of hot coffee and a little heat at any time during the day. The contractors would have preferred to let out the commissary, but a provision in the contract required that this service be provided for the men at no profit, and it was determined that this could not be done except by the general contractors.

The Office of the Quartermaster General established "Safety Requirements" for excavation, buildings, and construction, for the conduct of the work. The contractors were glad to comply with these requirements because they were very practical in their application. Enforcement was maintained by the Second Zone Safety Engineer and a Resident Safety Inspector on the staff of the Constructing Quartermaster. The insurance carriers were very cooperative in securing compliance with these safety requirements.

As a medium for contact with the personnel, a 12-page magazine was published by the Service Department and distributed each week with the pay envelopes. A patriotic editorial, a few original poems, camp news and humor, and articles on safety, fire prevention, camp deportment, traffic regulations, and similar subjects were published. Circulation reached 8,500 weekly and contributed greatly to morale and to the centering of attention on common interests.

Much time was devoted to maintaining good relations with the public and with labor. The work was completed without a labor strike and without any adjustment in the labor rates originally set up by the Department of Labor for the project. The peak number of men employed was about 8,000, which was reached in January of 1941.

The War Department was able to furnish all necessary information with reasonable speed and also to put an efficient organization in the field promptly. The Architect-Engineer was fortunately in a position to immediately organize an adequate field and office staff. In tribute to this organization it should be said that there was no serious delay due to the lack of necessary information and plans or in the laying out of the work. The joint contractors also furnished, at once, about fifty key men from their permanent organizations and also made available executives of both companies who spent their entire time in operating the project.

The field representative of the War Department was Maj. Gerald R. Tyler, Constructing Quartermaster. A. B. Squire was resident engineer for the Engineer-Architect, and William S. Lozier, M. Am. Soc. C.E., also devoted most of his time to the work.

Daniel B. Niederlander, vice-president and general manager of the John W. Cowper Company, and E. P. Palmer, secretary and treasurer of Senior and Palmer, managed the project for the contractors. John J. Knudsen was Assistant Project Manager; A. Bruce Silverthorn was General Superintendent of Building Construction; and J. F. Armstrong was General Superintendent of Utilities Construction.

Concrete Mixing Plant for Friant Dam

By C. T. Douglass

Engineer, U.S. Bureau of Reclamation, Friant Division, Central Valley Project, Friant, Calif.

Friant Dam Concrete Plant
Aggregates and Pumice Arrive by Conveyor Belt, While Concrete Leaves in Bucket Cars

At Friant Dam the concrete mixing plant was located on the south side of the San Joaquin River about 200 ft downstream from the dam site and 100 ft lower than the crest elevation. The maximum concrete production for a 24-hour period was attained on July 29, 1941, when 9,059 cu yd of concrete were produced. In this peak run, 1 cu yd of concrete was manufactured every $9^1/_2$ sec during the 24-hour period.

The three floors in the concrete mixing plant were laid out so that the raw materials entering on the top level were fed by gravity to the second level or batching floor, and thence to the third level or mixing floor, where four 4-cu yd mixers were located. From the mixers the concrete was dumped into buckets on the train below the plant and transported over the trestle, to locations where the buckets were handled by cranes.

Sand and the four sizes of gravel were stored separately at the track hoppers. The latter were downstream from the dam and at a level approximately 250 ft below that of the mixing plant. Aggregates were transported 970 ft to the mixing plant over five flights of 36-in. belt conveyor moving at the rate of 400 ft per min. Each track hopper was provided with two gates, which in opening swung on a horizontal axis and were operated, singly, by the admission of compressed air to an operating ram controlled by solenoid valves. Circuits to the solenoids were controlled at a switch panel located above the aggregate bins on the top floor of the plant. With this arrangement it was possible for the operator to select the aggregate desired for transit on the belt to the mixer bins. A pivoted distributor chute was located at the end of the conveyor belt to lead each size of material into the correct bin.

The overhead storage was divided into six 200-cu yd bins constructed of steel and laminated wood. Five of these bins were used to store aggregate and the sixth, a circular compartment of 1,900-cu ft capacity, was for pumicite. The cement compartment, which was surrounded by the aggregate bunkers, was of steel construction and had a capacity of 750 bbl. There was a dust collector above the cement bin.

Pumicite was fed from the truck hopper through corrugated rollers set $^3/_4$ in. apart, then transported on an 18-in. conveyor belt to a 250-cu yd silo. From the silo it was carried on another 18-in. belt to the mixing plant bin, as required. The pumicite as it arrived at the plant contained moisture varying from 15 to 35% by weight. As the moisture increased, the pumicite tended to lose its free-flowing character. To facilitate its movement for batching, a series of three 2-in. jets introduced air at 100-lb pressure along the side of the bin. The entrance of air was manually controlled by valves located in the batcher operating room.

Water for concrete mixing was pumped from the San Joaquin River to a 100,000-gal storage tank, placed higher than the crest of the dam and 500 ft upstream. From May 15 to October 1, because of the high temperatures of air, water, and aggregate, it was impossible to produce concrete below the maximum specified temperature of 70 F without the aid of a cooling agent. During this period, therefore, water at 32 F, containing slush ice, was used for mixing.

Automatic Batching Equipment

From the overhead storage bins previously described, cement and aggregates flowed by gravity to weighing batchers installed directly beneath. The plant was provided with individual batchers for sand, four sizes of aggregate, cement, pumicite, water, and tempering water. Each batcher had its individual weighing, cutoff, and recording beams, and a full-capacity dial.

Each of the sand and gravel batchers was charged by an air-operated slide gate. Compressed air for the operating cylinders was controlled by solenoid air valves, and circuits to the solenoids were operated by mercoid switches on a special cutoff beam in the beam-box located under the dial. Batchers were charged by fully opening the slide gate to admit about 90% of the material. The final 10% was then admitted slowly by opening and closing the gate rapidly with the automatic dribble feed. This dribble feature, used near the close of the charging operation, made it possible to cut off the final weight with extreme accuracy. Each scale was provided with four cutoff beams, making it possible to have set weights for four different mixes. Three of the four beams were automatically locked out by a selector control valve during operations, leaving only one active beam for weighing the necessary materials for the particular mix desired.

Under normal operating conditions, all batcher charging operations were controlled automatically by appropriate weight settings on the cutoff beams. These operations, however, could be controlled by hand operation of the solenoid-

It is a long step forward from concrete mixing as it used to be done by hand to modern concrete production in bulk for large dams. Only a few years have seen this change take place. Many engineers will remember the gangs of men that mixed concrete with shovels on the street surface and then wheeled it in barrows to the forms of our first subways. Others, also not so old, can remember building dams with masonry shells, the center filled with plum stones dropped in concrete and mortar. With these recent procedures in mind, the engineer will be doubly impressed as he enters a modern concrete plant. Here buttons are pressed, indicator lights flash, and tons of accurately weighed aggregates flow from bins to mixers. This article, third in the series on Friant Dam, describes a plant where average production is 6,000 cu yd a day and peak production above 9,000.

CEMENT SILOS AND UNLOADING DOCK
Small Building Houses Compressors and Transport Pump

operated valves, with the aid of the dials, should a breakdown occur in the automatic features. Under ordinary conditions there was no necessity for manual control, as the automatic equipment was found to be entirely satisfactory.

Materials were released from the batchers through gates actuated by electrically controlled compressed-air rams. The maximum mixing efficiency was attained in the minimum time when the mixers were charged by threading the materials into the mixers rather than by dumping the batchers simultaneously. To accomplish this ribbon feed, the batcher dump-gate openings were made adjustable so that the emptying of the batchers could be delayed as desired. In addition, solenoid-operated valves controlled by a three-stage delay timer were installed in the air lines leading to the dump rams. With this arrangement it was possible to select many combinations of batching sequence. A suitable sequence was arrived at experimentally and controlled by mixer efficiency tests. The batching sequence normally used is shown in Table I.

From this table it will be noted that water and cobbles were in the first stage and led the second stage by $4^1/_2$ sec. The purpose of the first-stage lead was to introduce all the cobbles and a part of the water ahead of the other materials so as to allow a short period for scouring action on the mixer shell and blades. The second stage in the charging sequence, consisting of sand, fine gravel, intermediate gravel, and pumicite, led the third stage of cement and coarse gravel by $1^1/_2$ sec. The batcher gates were adjusted so that the aggregates, including the coarse gravel in the third stage, trailed the cement and pumicite by $1^1/_2$ or 2 sec to sweep down the collecting cone and charging chute. The water, while leading all the other ingredients, was threaded into the mixer during the charging process, and by means of an adjustable gate in the water spout was caused to trail all other materials by 2 to 4 sec. This arrangement permitted dispersion of the water throughout the entire batch during charging, and also served to wash down the nose of the mixer.

The refilling operation was started immediately after the gates were closed. Filling the batchers with about 9 tons of material, including water, within an accuracy of 1%, was accomplished within 10 sec. Approximately 15 sec were required to charge the mixer. The total time required to tilt, discharge, and return the mixer to a charging position was 12 sec.

MIXING PERFORMANCE AUTOMATICALLY RECORDED

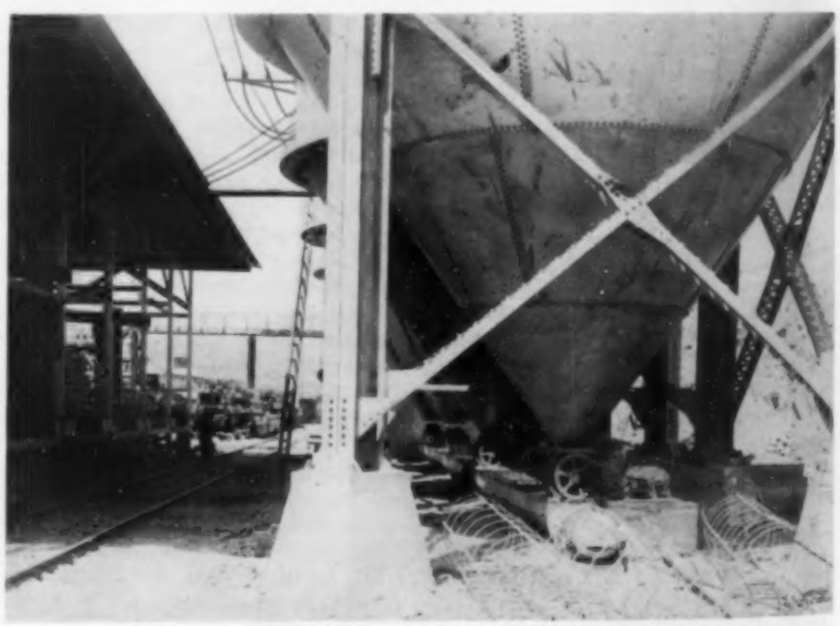
A complete and continuous plant performance record with the time of mixing, concrete consistency, and weights of ingredients for each batch was provided by an automatic recorder. The movement of each weighing beam was transmitted to its pen on the recorder sheet by two balanced impedance coils, one in the scale head and the other in the recorder cabinet.

The plant contained four 4-cu yd, front-charge, tilting-type mixers, placed around a central receiving cone.

TABLE I. BATCHING SEQUENCE

MATERIAL	BATCHER GATE OPEN AT SECONDS	BATCHER EMPTY AT SECONDS
First stage:		
Water	0	$2^1/_2$
Cobbles	0	$4^1/_2$
Second Stage:		
Sand	$4^1/_2$	$10^1/_2$
Pumicite	$4^1/_2$	$8^1/_2$
Intermediate gravel	$4^1/_2$	$10^1/_2$
Fine gravel	$4^1/_2$	10
Third stage:		
Coarse gravel	6	13
Cement	6	12

(Water was arranged to trail all other materials by 2 to 4 sec)



ELECTRIC MOTOR FEEDS CEMENT INTO CONVEYING SCREW AT BASE OF SILOS

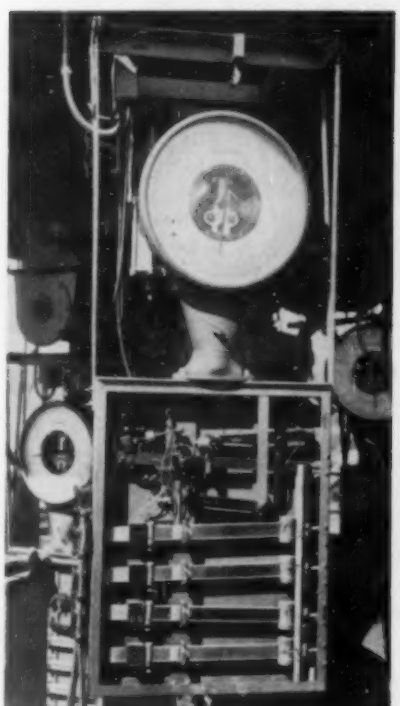
The mixers were charged through a retractable swivel chute that made contact with the nose of the mixer selected. The mixers when empty rested on a backward tilt of 15°. Each mixer was driven by a 75-hp motor installed in the tilting frame and rotated at 10 rpm. All the mixers were provided with consistency indicators actuated by a shift in the center of gravity of the batch of concrete in the mixer. As the batch became more workable because of increased wetness or other contributing factors, it would move towards the nose of the mixer, effecting a change in the thrust of the dump ram on the frame. This movement was picked up at the bottom of the ram, multiplied 200 times through mechanical linkage, and transmitted to two balanced impedance coils, one in the consistency meter and the other actuating the pen on the recorder sheet.

Each batch of concrete in the mixer was automatically timed, and at the expiration of the mixing period the dumping mechanism was automatically unlocked, permitting the operator to tilt and empty the mixer by introducing compressed air into the dump rams. Each mixer had three blades spaced equidistant about the mixer shell, parallel to the mixer axis, having an angle of 10° toward the mix. Through the proper arrangement of mixer blades and introduction of materials, it was possible to permit a reduction in the mixing time of from $2^1/_2$ to 2 min when the demand required, providing the mixer efficiency tests indicated that satisfactory mixing was attained at 2 min.

Construction of the plant was begun in December 1939 and completed in May 1940. More than 2,000,000 cu yd of concrete were produced, and the average daily output was approximately 6,000 cu yd during peak production.

DESIGN OF REFRIGERATING PLANT FOR SLUSH ICE

Near the mixing plant stood the refrigerating plant for furnishing the slush ice. This consisted of a duplex ammonia compressor with a capacity of 400 tons of refrigeration per 24 hours. One cylinder of this compressor operated at 20-lb suction pressure, and furnished ammonia to three 6-section freezers. The high-suction cylinder, operating at 50-lb suction, supplied the water pre-cooler, lowering the temperature of the water to 32 F before it was admitted to the freezers. The freezers consisted of cylindrical ammonia jackets with circumferential square ridges on the insides. A rotor, carrying stellite cutters, scraped the ice off the ridges in the form of a fine snow. The largest unit was the closed type; the rotor turned at 98.5 rpm and produced fine snow. The jacket interior was inundated with water at 32 F during operation. Power was furnished by a 20-hp motor. The two smaller machines were of the open type, and water was admitted through sprays located on the rotor just behind the scrapers. Part of the water froze on contact with the jacket. These two machines, which produced coarse slush, were driven by 5-hp motors, and the rotors turned at 14.3 rpm.



DIAL OF CEMENT SCALE, AS SEEN FROM OPERATOR'S BOARD, SHOWS DIRECTLY THE AMOUNT AUTOMATICALLY WEIGHED

RETRACTABLE CHUTE IN CHARGING POSITION
Water Distributor Ring Appears at Extreme Top of Picture

In all the machines, the snow was carried off in the excess water that passed through. The mixture of slush ice and water was then pumped to the concrete mixing plant through a 4-in. insulated pipe line. The water batching system in the mixing plant was revised, after considerable experimenting and extensive alterations, to provide a surge or concentrating tank. This tank served to concentrate the ice before delivery to the batcher. It was impossible to make an accurate determination of the percentage of ice present in the batching water, but indications were that the maximum concentration did not exceed 20%.

As provisions for handling slush ice were not included in the original mixing-plant design, several alterations were necessary before this could be satisfactorily transported to the mixers. The slope of the bottom of the water batcher was increased to about 45°, and the inclination of the pipe leading from the batcher discharge to the collector ring was increased to facilitate the flow of water and ice. The collector ring surrounded the lower part of the collector cone and directed the water to the mixer being charged.

LABORATORY AND TESTING FACILITIES PROVIDED

The testing facilities provided by the project were housed in a main laborabory building, which also contained office space. Two small laboratories for field control were located at the aggregate and concrete plants, and these contained sufficient equipment to analyze job conditions thoroughly without delay. Daily, weekly, and monthly reports of the activities supervised by the concrete-control department were compiled. All special investigations and preliminary studies were conducted by the Denver Office of the Bureau of Reclamation, but the field laboratory performed all the physical control tests and special investigations required for immediate use on the job.

All testing and inspection connected with aggregate processing and concrete production, to the point where the concrete left the mixing plant, was supervised by the writer under the direction of R. B. Williams, M. Am. Soc. C.E., construction engineer, Friant Division of the Central Valley Project.

A Proposed Live-Load Reduction Formula for Buildings

Sponsored by Sectional Committee A58 of the American Standards Association

By C. W. Barber

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The problem of building code provisions for live loads has never been completely solved to the satisfaction of civil engineers. The latest effort in this direction is the work of the American Standards Association's Sectional Committee A58, on Building Code Requirements for Minimum Design Loads in Buildings, of which the writer is a member. This committee is engaged in the preparation of recommended basic requirements for consideration when local building codes are prepared or revised. Its work with reference to column and other loads is in effect a continuation of the activity of the Building Code Committee of the Department of Commerce, which committee in 1924 issued a report entitled "Minimum Live Loads Allowable for Use in Design of Buildings." Much of the success of this earlier work is attributable to the procedure followed of subjecting proposed requirements to critical review through publication in engineering journals. The same procedure is contemplated in connection with the work of the A.S.A. Sectional Committee, and the following discussion of its proposed formula for structural members, particularly columns, is presented in the hope that it will draw forth general comment.

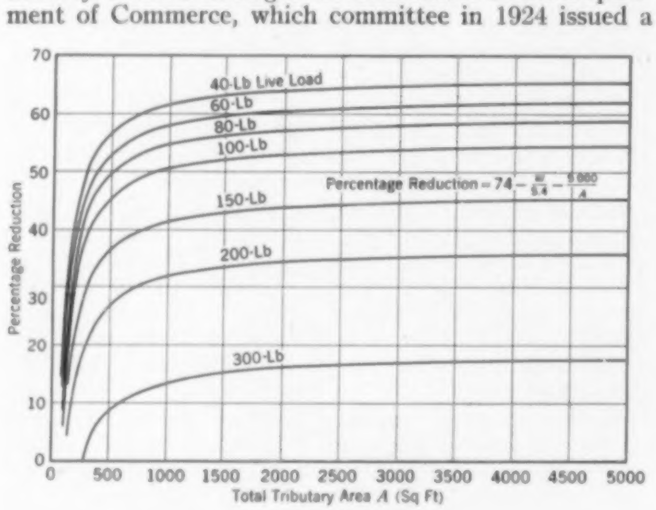


Fig. 1. Plot of Proposed Formula for Live-Load Reduction

Reduction of live load in buildings has been more or less arbitrary and not adequately covered in detail by any building code. Many, in fact most, codes are deficient in rules covering special cases—notably girders carrying columns, changes in tributary floor area, exterior wall columns that become interior columns, columns carrying varying live loads on successive tributary areas, and particularly live loads on floor members.

If each structural member is visualized as supporting a floor area, it then follows that the reduction for lower stories, for example, should be a direct function of this supported area rather than a function of the number of increments comprising the area. Furthermore, the live load of light occupancies will be less fully realized than that of heavier occupancies over an equal area, and therefore the reduction should be an inverse function of the live load.

Using these two factors, the area supported and the live load, the following is proposed for live-load reduction in columns and other members by Sectional Committee A58 of the American Standards Association:

No reduction shall be applied to the roof live load. All other increments of live load for lower columns or girders may be reduced by the following formula, when R is positive:

$$R = 74 - \frac{w}{5.4} - \frac{5{,}000}{A} \qquad (1)$$

where R = reduction, in per cent
w = unit live load for the increment involved
A = total accumulated area, at the section considered, but excluding roof area

For successive areas, as in columns, the total live load in any section shall be taken as the sum of the separate increments of load. All reductions shall be applicable to the original unit live load only.

This formula, Eq. 1, plotted in Fig. 1, yields a reduction that varies inversely with the unit live load (small unit load, large reduction; large unit load, small reduction) and varies directly with the area.

The formula, as proposed, applies the reduction to successive increments of load, and the load in any section of a column, or on any girder should be taken as the sum of these increments. Applying the formula to the total live load results in a slightly smaller total reduced live load and would be contrary to the probable load to be realized. It is evident that the load to be realized from a given area will be greater if it is in a number of increments than if it is in one increment. On a small area, the indicated reduction is a negative quantity, in which case no reduction is allowed.

Each design office will readily develop its own methods and tables for simple application of the reduction formula. For instance,

$$\%\ \text{carried} = 100 - 74 + \frac{w}{5.4} + \frac{5{,}000}{A}$$

Reduced unit load carried =

$$\frac{\text{percentage}}{100} \times w = w\left(0.26 + \frac{w}{540}\right) + \frac{50w}{A}$$

Let a = increment of area, then

$$\text{Load for this increment} = aw\left(0.26 + \frac{w}{540}\right) + (50w)\,\frac{a}{A}$$

Let $w\left(0.26 + \frac{w}{540}\right) = w'$; and $50w = K$

The expression then becomes

$$\text{Load for this increment} = aw' + \frac{a}{A}K \qquad (2)$$

TABLE I. CONSTANTS FOR GIVEN LIVE LOADS TO BE USED IN EQ. 2

w, in Lb	w', in Lb	K, in Kips	w, in Lb	w', in Lb	K, in Kips
40	13.3	2.0	175	102.2	8.8
60	22.3	3.0	200	126.0	10.0
80	32.7	4.0	250	181.0	12.5
100	44.5	5.0	300	245.0	15.0
125	61.3	6.3	350	318.0	17.5
150	80.6	7.5	400	400.0	20.0

For given live loads, w' and K are constants and can be solved once and for all, and used for application to each increment of load. These constants are given in Table I. They are utilized in Tables II and III for computation of the results shown in the three columns under the heading of live load. The first of these columns represents aw'; the second represents $\frac{a}{A} K$; the third, or total column, represents the completion of the formula.

The quantity a is computed by the procedure that has always been required in obtaining column loads. The use of the quantity A, which is the summation of all the a's, whether all equal or all different, is a new step in the calculation for loads and their reduction. It is the very step, previously omitted by engineers, which serves as a measure of the amount of reduction that might be reasonably applied.

TABLE II. HYPOTHETICAL COLUMN CARRIES A ROOF AND EIGHT FLOORS WITH UNIFORM FLOOR AREAS AND UNIT LOADS

Floor	a Sq Ft	A Sq Ft	Unit Live Load Lb	Unit Dead Load Lb	w'	Live Load, Kips: aw'	Live Load, Kips: $\frac{aK}{A}$	Live Load, Kips: Total	Dead Load, Kips: Design	Dead Load, Kips: Col. Shaft	Dead Load, Kips: Total	Total Load, Kips: For Increment	Total Load, Kips: Design Load
Roof	200	...	40	95	40	8.0	...	8.0	19.0	2.0	21.0	29.0	...
8	200	200	80	137	32.7	6.5	4.0	10.5	27.4	2.0	29.4	39.9	29
7	200	400	80	137	32.7	6.5	2.0	8.5	27.4	2.0	29.4	37.9	69
6	200	600	80	137	32.7	6.5	1.3	7.8	27.4	3.0	30.4	38.2	107
5	200	800	80	137	32.7	6.5	1.0	7.5	27.4	3.0	30.4	37.9	145
4	200	1,000	80	137	32.7	6.5	0.8	7.3	27.4	3.0	30.4	37.7	183
3	200	1,200	80	137	32.7	6.5	0.7	7.2	27.4	3.0	30.4	37.6	221
2	200	1,400	80	137	32.7	6.5	0.6	7.1	27.4	3.0	30.4	37.5	259
1	200	1,600	80	137	32.7	6.5	0.5	7.0	27.4	4.0	31.4	38.4	296
B	...	..	..	...	..	...	...	...	..	...	..	..	334

The quantity a/A, multiplied by $50w$, is a matter for slide-rule computation. It represents one additional item in the usual column load sheet.

Some codes permit a reduction in the live load on a column but not in that on a girder loading this column, even if the tributary area to the girder is larger than that to the column. The proposed formula, Eq. 1, based on area carried rather than on floors carried, corrects this inconsistency by applying the reduction to any load-carrying number. Note that tributary area from an offset column on a girder must be properly carried to the column that supports the girder. The large area thus contributed enters very simply into the calculation for permissible reduction on this second column.

Two examples are given to demonstrate how Eq. 1 might be applied. In the first (Table II) a hypothetical column carries a roof and eight floors with uniform floor areas and unit loads. This is given for ready visualization of the method. The second (Table III) presents a hypothetical column carrying a roof and 16 floors, with variations in unit live loads and increments of tributary area. Readers might apply the reduction by the codes with which they are familiar to the columns given here for purposes of comparison.

The application of the formula to live load on beams may be illustrated by the following example:

A beam spans 20 ft and carries 5 ft of floor on each side, of 80 and 150-lb live load, respectively. The live load on the beam would be:

$$\text{80-lb side: } 5 \times 20 = 100 \text{ sq ft of } 80 \text{ lb, with } \frac{a}{A} \text{ of } \frac{100}{200} \text{ or } 0.5$$

$$\text{100-lb side: } 5 \times 20 = 100 \text{ sq ft of } 150 \text{ lb, with } \frac{a}{A} \text{ of } \frac{100}{200} \text{ or } 0.5$$

Then by Eq. 2, the reduced live load would be:

$$\text{80-lb side} \quad 100 \times w' + 0.5 \times K = \frac{100 \times 32.7}{1{,}000} + 4.0 \times 0.5 = 5.3 \text{ kips}$$

$$\text{150-lb side:} \quad 100 \times w' + 0.5 \times K = \frac{100 \times 80.6}{1{,}000} + 7.5 \times 0.5 = 11.8 \text{ kips}$$

$$\text{Total live load carried} = 17.1 \text{ kips}$$

The usual requirement is for the full live load, or $100 \times 80 + 100 \times 150 = 23.0$ kips.

Analyzing the reduction, it will be noted that the average load would be 53 lb for the 80-lb area and 118 lb for the 150-lb area. As the floor slab would be designed for the full load on any portion, it would be possible to place 80 lb on 60 sq ft and then have more capacity than necessary on the remaining 40 sq ft of the 80-lb area. Similar reasoning applies to the reduction of load for the 150-lb area.

The proposed formula recognizes that it is impossible to obtain a load of 8,000 lb on the area of 200 sq ft comprising the average living room of an apartment, or 16,000 lb on the area of an office, but that a portion of any area may be fully loaded. The probability of fully loading the entire area increases with the unit live load, and the load carried by the proposed formula increases with the live load until at 400 lb per sq ft the entire load is carried.

The author wishes to acknowledge the help of C. C. Ragsdale, formerly Associate Structural Engineer, Public Buildings Administration, for valuable assistance in developing the formula.

TABLE III. HYPOTHETICAL COLUMN CARRYING A ROOF AND 16 FLOORS WITH VARIATIONS IN UNIT LIVE LOADS AND INCREMENTS OF TRIBUTARY AREA

Floor	a Sq Ft	A Sq Ft	Unit Live Load Lb	Unit Dead Load Lb	w'	Live Load, Kips: aw'	Live Load, Kips: $\frac{aK}{A}$	Live Load, Kips: Total	Dead Load Kips: Design	Dead Load Kips: Col. Shaft	Dead Load Kips: Total	Total Load, Kips: For Increment	Total Load, Kips: Design Load
Roof	200	...	40	95	40	8.0	...	8.0	19.0	2.0	21.0	29.0	..
16	200	200	80	137	32.7	6.5	4.0	10.5	27.4	2.0	29.4	39.9	29
15	150	350	80	137	32.7	4.9	1.7	6.6	20.6	2.0	22.6	29.2	69
14	300	650	200	165	126.0	37.8	4.6	42.4	49.5	3.0	52.5	94.9	98
13	200	850	100	153	44.5	8.9	1.2	10.1	30.6	3.0	33.6	43.7	193
12	500	1,350	300	175	245.0	122.5	5.5	128.0	87.5	3.0	90.5	218.5	237
11	400	1,750	200	168	126.0	50.4	2.3	52.7	67.2	4.0	71.2	123.9	456
10	400	2,150	200	168	126.0	50.4	1.9	52.3	67.2	4.0	71.2	123.5	580
9	250		100	153	44.5	11.1	0.5		38.3				
	350	2,750	80	137	32.7	11.4	0.5	23.5	48.0	4.0	90.3	113.8	704
8	300	33,050	80	137	32.7	9.8	0.4	10.2	41.1	5.0	46.1	56.3	818
7	300	3,350	80	137	32.7	9.8	0.3	10.1	41.1	5.0	46.1	56.2	874
6	300	3,650	80	137	32.7	9.8	0.3	10.1	41.1	5.0	46.1	56.2	930
5	400	4,050	80	137	32.7	13.1	0.4	13.5	54.8	5.0	59.8	73.3	986
4	400	4,450	80	137	32.7	13.1	0.4	13.5	54.8	5.0	59.8	73.3	1,059
3	400	4,850	80	137	32.7	13.1	0.3	13.4	54.8	6.0	60.8	74.2	1,132
2	400	5,250	80	137	32.7	13.1	0.3	13.4	54.8	6.0	60.8	74.2	1,206
1	300	5,550	100	153	44.5	13.4	0.3	13.7	45.9	6.0	51.9	65.6	1,280
B	...	...	...	...	...	...	...	...	...	...	...	...	1,346

Drainage Problems on New Lake Mead Road

Unusual Conditions Overcome in Construction of Scenic Route on Nevada Side of the Lake

By GEORGE D. WHITTLE, M. AM. SOC. C.E.

SENIOR HIGHWAY BRIDGE ENGINEER, DISTRICT 2, PUBLIC ROADS ADMINISTRATION, SAN FRANCISCO, CALIF.

BUILT in a section that is very dry, yet subject to torrential rains, Lake Mead Road involved two major drainage problems. In places the terrain called for culverts of unusually large diameter; in other places, where channels were poorly defined, it was necessary to make the road itself serve as an overflow section. Water from cloudbursts was allowed to flow directly across specially built dips protected on one side with riprap and on the other with overflow aprons. The completion of this road opens up a new vacation area equipped with bathing beach, boats, cabins, and camping grounds.

TO build a road across broken desert terrain subject to summer cloudbursts was the problem before the Public Roads Administration on the recently completed 7-mile project along the Nevada shore of Lake Mead, extending from Hemenway Wash to Las Vegas Wash. This is one of three projects planned by the National Park Service to make accessible for fishing, boating, and recreational purposes the shores of the largest man-made lake in the world (Fig. 1). The road here described serves chiefly the Las Vegas and Boulder City area. Another such road reaches the lake near the old town of St. Thomas (now submerged), and one still under construction heads for the Arizona shore of the lake at Pierce's Ferry, a distance of 60 miles upstream from Boulder Dam.

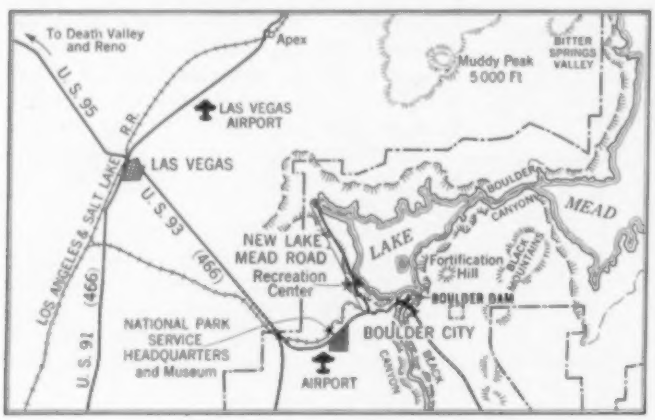


FIG. 1. LOCATION MAP OF LAKE MEAD HIGHWAY

Since the road roughly parallels the lake shore, crossing the natural drainage courses, and since the traffic will be entirely recreational, with few if any trucks, grades were sacrificed to good alinement. However, the grades are generally light although there are a few short stretches of 7%. Long sweeping vertical curves provide a minimum sight distance of 350 ft. The alinement is excellent, the minimum radius of curvature on the project being 2,000 ft except on two short spurs which connect the road with the lake shore near the end of the project.

MATERIAL HANDLED BY HEAVY EQUIPMENT

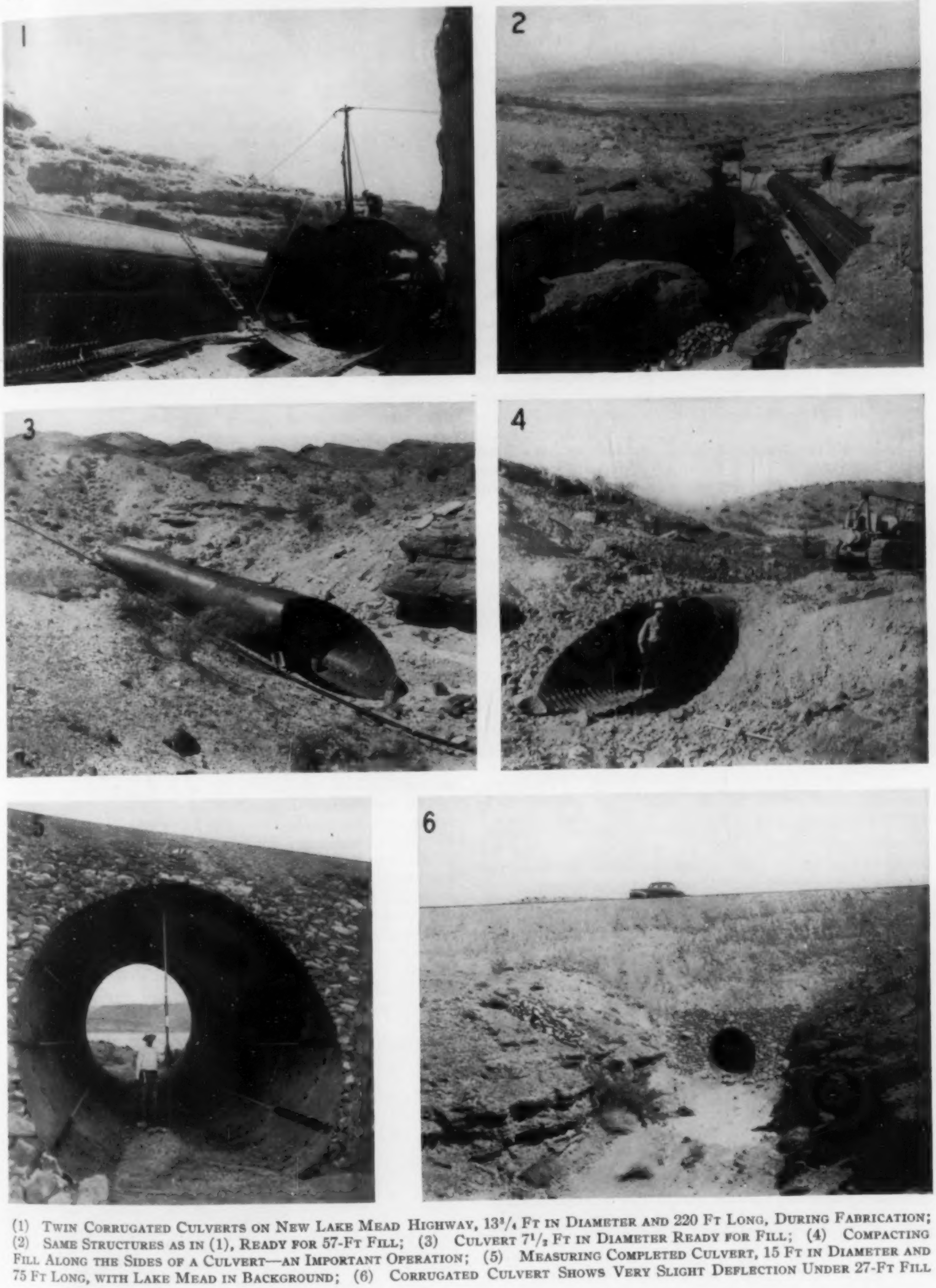
Extensive soil profiles were made. These showed generally good granular material from 2 to 6 ft deep overlying a well-cemented conglomerate. The latter was encountered in practically all the cuts. Material was handled by seven large tractors, a heavy-duty rooter, and 4 carryall scrapers of from 14 to 24-cu yd capacity. Three shifts with this equipment were run in order to complete as much of the grading work as possible before the hot summer weather set in. Compaction of fills was aided by two sheepsfoot rollers, and water for this purpose was pumped from Lake Mead through a 4-in. line, fill ayers being sprinkled with hoses.

The typical roadway section is 26 ft wide in fills and 28 ft in cuts. The top 6 in. was of gravel from specified borrow pits. On this sub-base a two-course surfacing was used; a 2 to 4-in. compacted thickness of crushed gravel base course for the full width of roadway, a prime coat of medium-curing cutback asphalt 20 ft wide, and a 2-in. top course of dense graded plant mix with seal coat. For this top course, 90+ asphaltic material (Type SC-6) was used in the proportion of 5% of the dry aggregates. Mixing was done in a portable plant having a pug-mill of 3,000-lb. capacity. The mixture was laid with a self-propelled spreading and finishing machine operated without side forms.

Shoulders 2 ft wide were used. These and the gutters were treated with a penetration application of medium-curing cutback asphalt applied at an average rate of 0.64 gal per sq yd at temperatures ranging from 160 to 208 F. A seal coat of rapid-curing cutback asphalt was used for

COMPLETED LAKE MEAD HIGHWAY OPENS UP FORMERLY INACCESSIBLE COUNTRY TO VACATIONISTS

ROADWAY OVERFLOW APRON IS USED WHERE RUNOFF CHANNELS ARE POORLY DEFINED



(1) Twin Corrugated Culverts on New Lake Mead Highway, $13^3/_4$ Ft in Diameter and 220 Ft Long, During Fabrication; (2) Same Structures as in (1), Ready for 57-Ft Fill; (3) Culvert $7^1/_2$ Ft in Diameter Ready for Fill; (4) Compacting Fill Along the Sides of a Culvert—an Important Operation; (5) Measuring Completed Culvert, 15 Ft in Diameter and 75 Ft Long, with Lake Mead in Background; (6) Corrugated Culvert Shows Very Slight Deflection Under 27-Ft Fill

A Riprapped Dike to Divert Surface Runoff

the pavement and shoulders. This was applied to the surfacing at the rate of 0.10 gal per sq yd, and to the shoulders at the rate of 0.32 gal per sq yd. Screenings were then spread on the shoulders at the rate of 10 lb per sq yd.

Although the annual rainfall in this section of the country averages only 6 in., much of it falls in the form of cloudbursts during the summer. Since the runoff is

Tractor and Scraper Sloping Shoulders to Provide for Proper Drainage

heavy on the bare steep conglomerate slopes, adequate provision for drainage was no mean item. Along the south end of the project, where the draws are wide and flat, with channels poorly defined, it was impracticable to concentrate the flow in culverts, even with diversion ditches and dikes to collect the water upstream, and in these cases it was necessary to use overflow sections or dips. For these a cement stone masonry cutoff wall was used along the downstream shoulder of the roadway, and below it an overflow apron of ogee shape built of rock with an asphalt topping. These aprons are from 10 to 32 ft wide, depending on the grade of the stream.

Elsewhere on the project the channels are better defined. Therefore corrugated culverts from 18 to 48 in. in diameter were used for the smaller openings and sectional or multiplate pipes from 75 to 180 in. in diameter in the larger washes. For these large pipes the manufacturer's recommended gages of metal for the various heights of fill were followed. At one location where the fill over the twin 165-in. pipes was 57 ft, it was necessary to use a special type with corrugations 6 in. wide and 2 in. deep, with gages as heavy as No. 1. At the other nine locations, where the fill depths varied from 6 to 30 ft, standard multiplate with corrugations 6 in. wide and $1^1/_2$ in. deep was employed. Lighter gages were used at the ends of culverts where the fill was less than under the roadway section. An extra thick plate was used in the invert for added resistance to abrasion.

Instead of using concrete headwalls for these multiplates, the ends were beveled and mitered at the shop to fit the slopes of the roadway fills, and the fills were then faced with rock riprap 2 ft thick. An apron of this riprap encased in wire mesh was used at the outlets of the pipes to prevent scour.

Following erection, struts were placed along the vertical diameter of the culverts, to jack them out of the round 3% of the diameter, with the expectation that they would deflect under load to about their theoretical circular shape. Granular material was used for backfill around the pipes, wetted and thoroughly compacted with equipment or by hand. Accurate measurements of vertical and horizontal diameters were made before the struts were removed and again a month or more after the fill was completed. These measurements showed that the pipe held very closely to its strutted shape and did not entirely return to the true circle, a testimony to the excellent compaction of the surrounding material.

Method of Placing Culvert Sections

Erection of the multiplates was handled with an average crew of seven men and one foreman. No special handling equipment was used for the 75 and 90-in. diameter pipes. On the larger pipes, the plates were handled by a stiff-leg derrick equipped with a snatch block and a double block and tackle, using a half-ton truck as a power unit. In the 150, 165, and 180-in. pipes the truck operated inside the pipe. This procedure was very effective, and required a minimum of time to set up the equipment and move it along.

Multiplate sheets used on this job had a total weight of nearly 300 tons, making it one of the largest installations on any highway project in the western states.

The only concrete specified in the contract was some 70 cu yd in the headwalls of the 18 to 40-in. pipe culverts. However, a shortage of aggregates from local commercial plants due to several nearby defense projects, made it necessary to change to cement stone masonry. Good stratified rock for this purpose was available.

The contractor was A. Teichert and Son, Inc., of Sacramento, Calif., whose superintendent and structure foreman were A. E. Hullin and Harry Schultz. C. H. Sweetser, M. Am. Soc. C.E., is the district engineer for the Public Roads Administration, and Eric E. Hopson was resident engineer on the project.

A Typical Wing-Type Headwall of Ashlar Masonry

Constructing the Delaware Aqueduct Under the Shawangunk Range

By Fred W. Stiefel, Assoc. M. Am. Soc. C.E.

Chief Engineer and Manager, Samuel R. Rosoff, Ltd., Kerhonkson, N.Y.

Tunnel construction, because of its danger, has always had a peculiar fascination for engineers. To be lowered down a shaft 800 ft below ground, then go a mile or more to a heading amid the roar of a drilling crew, is an adventure to the most hardened "tunnel stiff." Modern construction methods make this work possible with remarkable speed and safety. The section of tunnel construction here described is under the Shawangunk Range, where popping rock, methane gas, and large quantities of water under high head added to the difficulties. This paper was given by Mr. Stiefel before the Construction Division at the Society's Annual Meeting in New York, on January 21, 1942.

A number of unusual and interesting features characterize the 15 miles of tunnel construction known as Contract 313. This section constitutes a portion of the Rondout–West Branch Tunnel of the Delaware Aqueduct now under construction for the City of New York, under the supervision of the Board of Water Supply. The tunnel, a rock section, 17 to 19 ft in diameter, extends from approximately the town of Wawarsing in the Rondout Valley, southeast under the Shawangunk Range (a spur of the Catskill Mountains), to the town of Gardiner in the Walkill Valley. Three circular shafts of 14-ft finished diameter, have been sunk for access approximately five miles apart, one in each valley, 825 ft and 840 ft deep, respectively, and one between the valleys in the vicinity of Lake Minnewaska to a depth of 1,551 ft. These shafts are numbered consecutively 2, 2A, and 3, from the northwest southeastward.

The tunnel elevation is approximately 400 ft below sea level, and there is a maximum of 2,400 ft of overburden. The rock formation generally is interbedded Hudson River sandstone and shale lying practically horizontal with occasional dips up to 35°. Because of the extensive foliation, particularly under the mountains, much of the rock was under considerable stress, causing what is known as "popping rock." Under the Rondout Valley, about 750 ft below the surface, a badly faulted and crushed zone approximately 500 ft long was intercepted, and following this a stretch of 2,236 ft of very hard grit formation.

The longest heading, 15,549 ft in length, was driven to the north of the center shaft, Shaft 2A. At this shaft, the deepest of the aqueduct shafts, the headings frequently encountered inflows of methane gas, necessitating the introduction of a fire-boss system similar to that in use in gassy coal mines. All men were instructed as to the explosive nature of the gas and the fact that it is colorless and odorless, and thus cannot be recognized any more than can the oxygen and nitrogen of the atmosphere. Printed instructions were issued to each man. Smoking and the carrying of smoking articles was prohibited. Stringent fire prevention methods were carried out and no explosions occurred, although there were occasional delays.

In spite of the extreme length of the heading, the depth of the shaft, the presence of an explosive gas, and most unfavorable rock conditions necessitating 100% roof support (almost all of it directly to the face), excellent progress was made in this shaft. Using but one muck crew and one drill crew per shift for both headings, known as alternating headings, a daily average of 60.75 ft per day was maintained at the shaft in two headings. This compares excellently with the progress made at Shaft 2, of 55.74 ft per day, and that at Shaft 3 of 72.65 ft per day. The average progress per shaft for all three shafts was 63.24 ft per day. Shafts 2 and 3 were operated by independent heading crews after the headings had advanced 5,000 or 6,000 ft from the shaft.

A total of 66,430 ft of the 75,157 ft of tunnel, or about 88.3%, required roof support. Under the mountain, the horizontal layers of shale and sandstone were under such strain that the rock exhibited a tendency to burst upward and downward. On one occasion the upward thrust of the rock raised the haulage track to a maximum height of 20 in. for a distance of 500 or 600 ft along the tunnel. Over 42,000,000 lb of steel roof support and over 2,700,000 fbm of timber were used in all. A considerable length of tunnel was supported directly to the face using crown bar protection for drilling and mucking operations. At Shaft 2A, it was found necessary to gunite the rock around the posting of the wall plates to prevent losing the support of the posts through what is called air-slacking of the rock. In fact, guniting was resorted to in the roof where disintegration occurred within regions already supported. This was found satisfactory to prevent spalling.

A structural steel drill carriage with collapsible wings was provided in each heading. Five to seven $3^1/_2$-in. automatic, wet-type, mounted drills were employed with drill steel up to 15 ft in length. The length of round varied from 8 to 14 ft, depending to some extent on the condition of the rock. Incidentally, it was found that the longer rounds were more satisfactory where alternate

Fire Boss on Rear of Drill Jumbo Checks the Heading for Methane Gas

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headings were operated, while at independent headings shorter rounds were used to obtain maximum progress. In general, at Shaft 3, nine rounds per day of three shifts were drilled, shot, and mucked. At Shafts 2A and 2, six to seven rounds was the average.

Mucking was carried out by means of a 75-hp mucking machine, using 6-cu yd cars of streamline design. These were made adaptable to rotary dumping devices at the bottom of the shaft. The muck was dumped into two counterbalanced skips of 7-cu yd capacity, then raised and dumped into a 50-cu yd bin at the surface, where trucks were loaded by means of a pneumatically controlled gate.

The muck cars, specially designed by the contractor, were simply and ruggedly built, being merely steel boxes made up of plates and stiffeners, mounted on four roller-bearing wheels. Inside and just above the center of gravity of the car two eyes were placed, which were used to engage a pair of hooks attached to a bridle. This bridle was raised or lowered by means of a five-part line through a sheave at the roof and actuated by an air tugger hoist. This simple device, known as a cherry-picker, provided an efficient means of transferring the empty muck cars to the head of the train for serving the mucking machine.

GRIT FORMATION REQUIRED USE OF SPECIAL BIT

It was anticipated that the 2,236 ft of grit formation would be especially difficult to excavate because of its abrasiveness. This formation, a very hard conglomerate, had been pointed out to the contractor by the Board of Water Supply as a problem worth extra compensation in the form of a bonus of $^1/_4$ cu yd of excavation for every cubic yard excavated.

Before the grit was encountered, a special bit was developed. This was four-pointed but with practically no taper to the wings. The upper section was cylindrical so that the reaming effect on the hole was caused not only by the points of the bit but also by the receding edges. The design proved most effective, showed one-fourth the wear of the conventional four-point bit, and caused less steel breakage, fewer stuck steels, and less drill repairing than the conventional type used in the shale and sandstone.

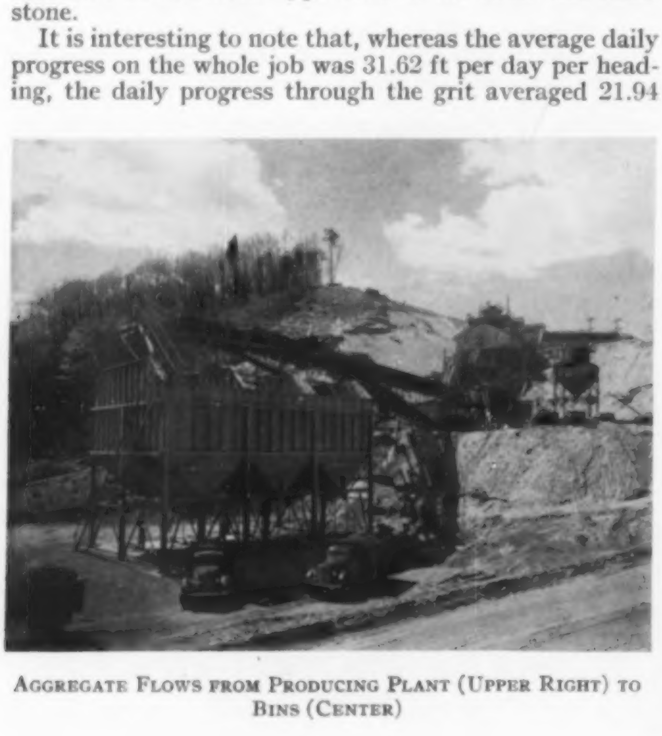
It is interesting to note that, whereas the average daily progress on the whole job was 31.62 ft per day per heading, the daily progress through the grit averaged 21.94 ft per day. This compares very favorably also with the progress in the north heading of Shaft 2, where a dense fine-grained gray sandstone was encountered. In this heading the average daily progress was 26.10 ft per day. The best single day's progress in two headings at one shaft was 104 ft at Shaft 3. The best progress in any one heading for one month of 26 working days was at Shaft 3, where 1,154 ft were driven in the south heading. The best single month's progress at one shaft was also at Shaft 3, where 2,219 ft of tunnel were driven in two headings in 26 working days. The best total progress for 31 consecutive working days at three shafts and six headings was 6,779 ft of tunnel.

CURB FORMS WERE POURED FIRST SO THAT CURB COULD BE USED TO SUPPORT BRIDGE USED FOR POURING INVERT

The dynamite consumption also reflects the quality of the rock. On the job as a whole this was 4.08 lb per cu yd. In the shales and sandstone of Shafts 2A and 3 the consumption was approximately 3.6 lb per cu yd. In the grit, it averaged 5.7 lb per cu yd, while north of Shaft 2, the requirement was 6.58 lb per cu yd. The total consumption on the entire job was 3,100,000 lb of 40% dynamite.

About 7,000 ft south of Shaft 2, in the Rondout Valley, a badly crushed and faulted zone was encountered, and here there was an exceedingly large inflow of water. Drill holes produced a maximum of about 3,000 gal per min at a pressure of 290 lb per sq in., which was about equivalent to the full hydrostatic head to the surface. Since the valley consists essentially of a huge gorge filled with glacial drift to a depth of over 400 ft, and is thoroughly inundated with water, the problem was most difficult. Had the tunnel been driven through this region without special treatment, it is estimated that a flow of 20,000 to 40,000 gal per min would have been encountered. The rock seams were so numerous and minute in width, frequently with no interconnection, that it was impossible to employ the usual method of grouting in this work.

Grout pumps were installed to permit application at a pressure close to 2,000 lb per sq in. Also, it was arranged to use this same pressure for washing out the drill holes and flushing seams with clear water. High early strength cement was forced back into the seams. This type of cement, being much finer, having a larger surface area, and resulting in a more fluid grout, traveled through interstices which would have become plugged by the ordinary type of cement.



AGGREGATE FLOWS FROM PRODUCING PLANT (UPPER RIGHT) TO BINS (CENTER)

It was found that grout mixed by air agitation was better than that mixed by paddle agitators or other methods and was in fact superior to carefully prepared laboratory mixes. The laboratory mixes were made by adding water to the cement, first making a paste and then adding more water and thinning until the required consistency was attained. Laboratory mixes made by stirring were definitely inferior, as shrinkage tests showed.

Numerous tests showed conclusively that the high early strength cement yielded a grout with a set volume of about 90%, whereas the coarser cement specified by

TUNNEL FORMS IN PLACE READY FOR CONCRETING

the Board of Water Supply resulted in a volume when set of about 50% under the same conditions of water–cement ratio. That is, the high early strength type showed about 10% uncombined water whereas the coarser cement showed about 50% uncombined water.

It will of course be argued that since the high early strength cement grout shows a larger volume it is less dense and therefore has a lower unit strength. However, it fills up a much larger void. Since the function of most grouting, particularly in the case under discussion, is to assure the closing off of voids and to form a seal against the infiltration of water, strength is of secondary importance.

A study was also made on the effect of mixing time of air-agitated grout on the quality of the mixed slurry. Samples taken in the field during actual grouting operations showed conclusively that practically no difference in set volume occurred whether the slurry was mixed for 3, 5, 7, 9, or 55 minutes. This held true uniformly whether the mixture contained 8.6 gal per bag, 6.2 gal per bag, or 4.5 gal per bag.

SOLVING PROBLEMS OF CONCRETE TRANSPORTATION

In considering concreting procedure, it became evident that because of the excessive distances between shafts—about 5 miles—the problem of transportation was of paramount importance. Storage-battery locomotives of the type generally used for tunnel work are uneconomical for such a long haul. Trolley locomotives are not only dangerous but cumbersome and present difficulties in electrical transmission. It was decided therefore to use diesel power. At present, five 160-hp, 14-ton, 1,600-rpm units are being employed. Since this type of transportation for tunnel work was an innovation, numerous operating problems had to be overcome, such as providing proper scrubbing and cooling devices for the exhaust gases and the installation of adequate ventilation. The New York State Department of Labor ruled that 10,000 cu ft per min of ventilation should be provided for each diesel locomotive in service.

These locomotives have been in operation for over eight months and under a carefully planned system of maintenance and operation have proved successful. In future, there is no doubt that diesel locomotives will play a prominent part in tunneling operations, particularly for long-distance haulage.

With this type of power, from 1,500 to 1,700 cu yd of concrete, or approximately 3,000 to 3,400 tons of material, have been placed in 24 hours at a five-mile haul. During mucking operations, a single diesel locomotive hauled as many as 20 loaded muck cars of 6-cu yd capacity, each having a gross load of 11.6 tons. The total load moved (including weight of locomotive) was 245 tons on a practically level grade.

The concrete plants at all three shafts were of similar design and consisted of three 1-cu yd mixers at the surface, fed by an automatic batching plant, which in turn receives the aggregate and cement from overhead bins. The aggregates are elevated to the bins by a system of horizontal and inclined conveyors. Batching is done in 15 to 18 sec, and mixing in one minute. Since the mixers discharge successively, a batch can be produced every 30 sec.

From the mixers, the concrete is dropped down the shaft through a 12-in. steel pipe, thence to a hopper at the bottom to be loaded into the 5-cu yd agitators. Four of these agitators hauled by a diesel locomotive constitute a train. The train is then hauled to the forms at an average speed of 15 miles per hour, dumped into the invert, or in the case of the arch, into two pneumatic placers.

This method of operation presented numerous problems, not the least being the effect of dropping concrete 1,550 ft down Shaft 2A. The problem of impact at the bottom of the shaft was overcome by erecting a surge chamber, consisting of a 20-in. pipe properly reinforced around the periphery with steel rails and bands. It was found that little if any segregation occurred at the bottom. By many tests, it was found that concrete made into test samples after two hours in transit showed no decrease in strength. Concrete which left the mixer at a 7 to 8 in. slump, and was dropped 1,550 ft, increased in strength and reached the form with a 4 to 5-in. slump. It showed an average crushing strength of well over

SECTION OF COMPLETED TUNNEL

WATER-BEARING STRATA WERE GROUTED FROM A PILOT TUNNEL PUT THROUGH AHEAD OF MAIN TUNNEL

5,000 lb per sq in. after 28 days. For comparison, test cylinders were taken at various points in transit. In general, the strength of samples increased rapidly up to 10 min after mixing, then slightly up to 2 hours.

On November 14, 1941, a series of concrete test cylinders were made at Shaft 3. These were formed of concrete taken at the top and bottom of the shaft and at the forms over varied intervals of time. One series of tests, consisting of three cylinders, was made at the top of the shaft, of concrete which was $2^1/_2$ hours old, and which was not agitated during this interval except that it was turned over 4 or 5 times. Crushing tests showed an average strength of 5,640 lb per sq in. after 28 days, which was greater than any of the tests made on concrete in transit for shorter periods.

These tests indicated that free uncombined water was a detriment to the strength of the concrete, but that the more the water was given an opportunity to combine chemically with the cement, the stronger the concrete became. In other words, the idea that cement should be starved of water indiscriminately is a fallacy.

Concrete operations in the tunnel were planned to obtain systematic mass production, with an efficient sequence of operations. First, the cleaning gang started at one end and proceeded up the tunnel, cleaning the steel and side ditches of loose fly rock. Then followed the pouring of a curb on each side of the tunnel to fix the alinement of the invert and arch forms.

By using a collapsible form, with vertical wood sheathing, from 500 to 800 ft of curb was poured regularly in one heading in an 8-hour shift. This was followed by cleaning of the invert with a combination bulldozer and scraper arrangement. During this operation, the rails were removed and laid on the curb to form a wide-gage track for the concrete bridges. Progress was generally about 500 ft per 24-hour day, while 0.3 cu yd of muck was removed per running foot of tunnel.

Invert concrete was poured directly from a 1,200-ft bridge, and the invert was then screeded with a heavy curved screed running on side forms and drawn by a 6,000-lb line-pull tugger hoist. This operation was performed twice a week on two shifts with a progress of 1,100 lin ft in two shifts.

The arch concrete followed the placing of the invert. Collapsible telescopic forms were used which permitted continuous pouring. Two pneumatic placers were fed directly from the train of four 5-cu yd agitators. Daily progress has been well over 400 ft of tunnel, or from 1,500 to 2,000 cu yd of concrete placed.

Prior to holing through, ventilation was another important problem, not only to provide enough fresh air for ordinary tunnel operations but also to remove the methane gas frequently encountered. Each drill carriage had an 8,000-cu ft per min blower which evacuated the air directly from the face through two air ducts, one near the bottom and one near the top of the carriage. The discharge of the blower was connected to the main 28-in. steel vent pipe by means of a collapsible 16-in. vent tube. Thus it was possible to carry the 28-in. pipe to within 100 ft of the face, well out of range of the fly rock and yet close enough to maintain adequate local ventilation in the heading. The 28-in. pipe was carried for the length of the tunnel, then up the shaft and to a 13,000-cu ft per min centrifugal blower at the surface. Each shaft was provided with two such blowers. By means of blast gates it was possible to use the blowers to exhaust from either heading or both simultaneously.

By this method, the rock dust created by drilling as well as any methane gas encountered was immediately diluted and removed. Dust counts were kept below the requirements of the State Labor Department, and no gas explosions occurred.

The Board of Water Supply is represented on Contract 313 by Charles M. Clark, chief engineer; Roger W. Armstrong, deputy chief engineer; Neil C. Holdredge, department engineer; and O'Kelly W. Myers, senior division engineer—all except the first, Members Am. Soc. C.E. On the job for the Board are Max F. Freund, Assoc. M. Am. Soc. C.E., division engineer; John G. Mergott, Roderic C. St. Leger, and Francis J. Colgan, assistant engineers; John Horn, senior section engineer; and Arthur E. Hilliard, Assoc. M. Am. Soc. C.E., section engineer. The operating staff of Samuel R. Rosoff, Ltd., is made up of Samuel R. Rosoff, president; Arthur H. Diamant, Assoc. M. Am. Soc. C.E., vice-president; the writer, manager and chief engineer; James Fisher, general superintendent; Philip S. Miller, Assoc. M. Am. Soc. C.E., resident engineer; Anthony T. Araneo, construction engineer; David E. Stinson, general master mechanic; R. J. Visconte, master electrician; W. Quick, superintendent Shaft 2A; L. S. Penland, superintendent Shaft 2; Walter Dunham, superintendent Shaft 3; and Claude Young, safety engineer.

BATTERY OF SIX ELECTRIC PUMPS, EACH 1,000 GAL PER MIN AT 1,000-FT HEAD

Three Such Batteries Keep the Tunnel Dry

Rebuilding a Suspension Bridge

Structure at Des Arc, Ark., Provided with New Anchorages, Cable Ends, Hangers, and Floor System

By John Strom

Senior Highway Engineer, Arkansas State Highway Commission, Little Rock, Ark.

SOME of the most difficult construction problems are presented when it is necessary to partially rebuild an existing structure without taking it completely down. Loads have to be transferred to temporary structures and then back to new permanent installations. In this rehabilitation of a suspension bridge, the load transfer was through cables and cable clamps, special precautions being taken to guard against stress concentrations. The old and damaged ends of the cables were removed and new wire ropes fastened to new and improved anchorages. At small cost, the result is a safe structure, designed for modern traffic and having many useful years ahead of it.

INCREASES in traffic loading, combined with physical deterioration, made it imperative to reconstruct the suspension bridge over the White River at Des Arc, Ark. As a result the strengthened structure has been given many added years of useful service.

The toll bridge, privately owned, was built in 1928, on State Highway No. 38. The mid-span is 650 ft long and the side spans each 320 ft. The east and west treated timber approaches are 760 and 600 ft long, respectively, giving a total length of 2,650 ft.

Each cable consists of 1,100 No. 9 galvanized wires strung singly in place. The main and rest towers are of steel. There are no stiffening girders. The anchorages consisted originally of concrete blocks buried in the earth. The east one, being below high water, was flooded at overflow stages of the river. The cables were fastened to the anchorage by turning the individual wires around a 4-in. pin driven inside a 5-in. double extra strong pipe. Similarly wires from the anchorage were wrapped around this same pin, as shown in an accompanying view.

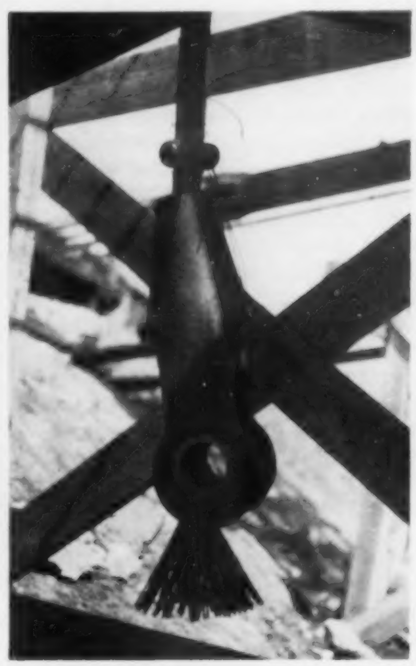
Bridge Completed and Open to Traffic

The Original Cable Anchorage—Wires Wrapped Around Steel Pin Embedded in Concrete

This bridge, freed from tolls, came under the supervision of the Arkansas State Highway Department in the spring of 1940. Immediately the Bridge Department began an investigation of its condition. Particular attention was given to the wires forming the cables where they entered the concrete near the anchorages, and at a point on the east end where the cables extended through an earth embankment. While the cables at these points were encased in concrete, moisture could penetrate by following down the wires. When the encasement was cut away, it was found that the wires were badly corroded and many were broken.

A traffic count over a two-week period showed an average of 200 vehicles a day, insufficient to warrant erection of a new bridge at this time. Because of the unsafe condition of the anchorage ends of the cables, the bridge was closed to traffic and a ferry installed, using as much of the old ferry landings as were still in existence after a lapse of twelve years. Then the timber deck, stringers, and felloe guard on the bridge were removed completely, as well as alternate floor beams together with hangers, so as to bring the tension in the cables down to a minimum.

Inspection of the cables showed them to be in good condition except for the damaged portions at the ends. The 9-in. floor beams were too weak to carry present-day truck axle loads, and the hangers also were



New Socket Placed on Strand, Wires Broomed Ready for Cleaning

TEST SET-UP FOR DETERMINING SLIPPAGE OF WIRES IN CABLE

found to be weak. Preliminary calculations indicated that the cables had sufficient strength to carry a heavier floor system and live load if some method could be found to splice new bridge ropes into the old main cables, and anchor them above ordinary high water.

The computed capacity of the old floor beams (9-in., 21-lb, I) was found to be $2^{1}/_{2}$ tons, and that of the old hangers ($1^{1}/_{8}$ in. round) $5^{1}/_{2}$ tons. The floor system was then redesigned for a 10-ton live load. The floor beams were changed to 14-in. 34-lb wide-flange beams and the hangers to $1^{1}/_{4}$-in. diameter upset to $1^{5}/_{8}$-in. diameter. At the same time, another line of 3 by 12-in. treated stringers was added.

Typical specimen wires were cut from among the 1,100 wires of the main cable after the removal of part of the floor system. These were tested and found to have an average ultimate strength of 104,000 lb per sq in. With the heavier floor system, the dead load stress in the main cable was found to be 425,900 lb. Assuming only one 10-ton truck in position for maximum stress in the cable, the factor of safety of the cables was 4.16, not considering any deterioration of the individual wires. By placing four 10-ton trucks close together for maximum stress, the factor of safety was reduced to 3. Considering the amount and character of the traffic using the structure, this was considered to be amply safe; therefore a method of cutting and splicing the cable was investigated.

After an intensive study of the problems involved, it was decided to look into the possibility of placing clamps on the main cable away from the anchors, which would hold all the wires fast so that temporary wire ropes could be attached to the clamps and tied back to the new anchorage. After that the main cable could be separated into smaller strands, the strands cut, re-socketed, and permanently connected to the new cable anchorage with new permanent wire ropes. Since there was some uncertainty as to whether clamps could be tightened on a bundle of 1,100 wires so as to hold them all without slippage, and ensure that all would act together, a test was made on a bundle of that number of No. 9 wires of the same breaking strength at the State Highway Department's shop.

Seven longer individual wires were left projecting at each end of the cable section at different parts of the cross section. The cable section was then clamped

NEW CABLE ANCHORAGES BUILT ABOVE AND BEHIND THE OLD

together with friction clamps like those secured to fasten the hangers to the cable. To each projecting wire, in turn, a clamp and dynamometer were attached, and by means of a small hand winch the pull required to cause slippage or breakage of the wire was determined. When the cable was held together with seven of the large friction clamps, practically no slippage of the wires in the cable was observed. The cable was then held together with ten clamps at 1-ft centers and all the wires tested broke at a pull of 1,800 lb or more, which was the average ultimate strength of the wires. All the wires failed between the first and second clamps at the end of the cable where the load was applied.

MAIN CABLES TIED DOWN SO THAT NEW ANCHORAGE COULD BE RAISED ABOVE HIGHEST HIGH WATER

Rods in Background Under Stress; Those in Foreground to Be Stressed When Temporary Strands Come Into Action

New anchorages were designed as shown in accompanying photographs. They were placed above and behind the old anchorages in order to take advantage of their weight and resistance to horizontal movement. The fastening on the new anchorage was raised 10 ft above the old in order to put the rope ends above ordinary high water. The old floor beams removed from the bridge were used as reinforcing, also to provide anchorage for the temporary ropes.

Raising the anchorage connection of the cables 10 ft would, unless some provision was made to prevent, change the sag of the cable in the suspended span and side spans. In order to maintain the same elevation of the old cable throughout the bridge, hold-down anchorages were built between the cable splice and the cable rest towers. These are also shown in a photograph.

The hold-down anchorages were fastened to the cable by means of four $1^1/_8$-in. round rods, formerly used as hangers on the bridge, and again the old floor beams were used as partial reinforcing. As the east hold-down anchorage is submerged at times of high water, it was made larger than the west one.

Temporary Cable Attached to I-Beams Embedded in the Main Anchorage

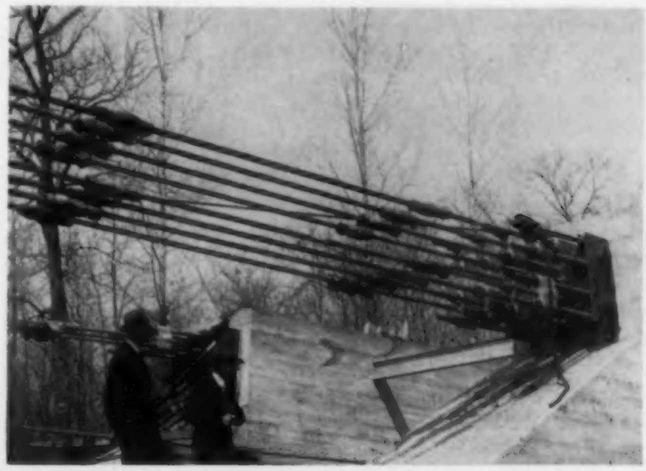
The load clamp for the temporary cable was placed on the main cable and the $1^1/_4$-in. bolts tightened. A collar spacer was next placed, then a pair of friction clamps. Collar spacers and clamps were alternated until ten clamps were in place (see photograph). Great care was used in placing the clamps and collar spacers so that they would have good bearing against each other. All the bolts were tightened and the two $1^3/_4$-in. temporary ropes fastened to the clamp by pins. The temporary ropes were then pulled back to the anchorage, and the cable sockets slipped over the $2^1/_4$-in. threaded rods already placed in the temporary anchorage connection.

All the ropes used were pre-stressed at the factory, and marked with zinc buttons so that each rope could be pulled to a predetermined stress. The nuts on the rods at the end of the temporary rope were gradually tightened, great care being exercised in keeping the stress in both temporary ropes equal by checking the zinc buttons frequently with the strain gage furnished. At the same time the cable rest towers were watched as an additional check on the strain gages.

When a stress of 96,000 lb had been reached in each of the temporary ropes, a slight movement toward the anchorage was noted in the cable rest tower; also there was a slight additional sag in the main cable between the temporary clamps and the anchorage, indicating that the main cable was relieved of stress. After a period of 18 hours, the friction clamps holding the main clamp were all checked and a small amount of slippage was observed. This was probably because the clamps and collar spacers were not in true bearing before the load of the temporary cable was applied.

The next operation was to separate the 1,100-wire main cable into 2-in. strands of 137 wires each. Since the wires had not been laid with much care, a number crossed from side to side. After considerable experi-

Temporary Cables Attached Each Side to Old Cable by Main Clamp, Which in Turn Is Held by Ten Friction Clamps



Main Cable Attachments to the New Anchorage

menting, the following procedure was worked out: First, 137 wires near the temporary rope connection were separated from the main cable and an oak wedge driven horizontally along the cable until there was sufficient room for one clamp. This clamp was then driven down to the wedge and tightened to a snug fit. The wedge and clamp were then driven along the cable, and as the work progressed clamps were placed along the strand at 4-ft intervals. When the point was reached where the strand was to be cut, all the clamps were given a final tightening, and the strand, held by tackle, was hacksawed at the proper point. A standard socket was slipped over the end; the end was broomed, scraped, and cleaned with dilute acid; and the socket was pulled up over the broomed end and filled with zinc.

Next, one of the new $1^1/_2$-in. wire ropes was attached to the socket and the U-bolts at the anchorage. The rope was stressed to 24,000 lb by the same method used for the temporary anchorage. Each additional strand was then separated and socketed in turn, until all eight strands were attached to the new anchorage, as indicated in a photograph. By following this method, only $12^1/_2$% of the main cable was out of commission at one time. In separating the main cable into the eight 2-in. strands, no broken wires were found. The principal trouble encountered was the criss-crossing of wires, previously mentioned.

When the socketing of the first main cable was completed, the temporary ropes were gradually released, then taken down and moved to the second main cable, and the same procedure followed. This was repeated at the other end of both cables. Upon completion of the cable splicing, new floor beams and hangers were erected, the new treated stringers and oak floor placed, and the bridge opened to traffic.

The investigation and redesign of the structure was made by the Bridge Department of the Arkansas State Highway Commission. Rebuilding of the bridge was carried out by the regular bridge maintenance crews under the supervision of the Bridge Department.

Sewage Disposal in a Southern Army Camp

Layout, Functioning, and Operation of Plant for 55,000 Men

By Robert M. Lingo, Jun. Am. Soc. C.E.

First Lieutenant, Quartermaster Corps, U.S. Army; Assistant, Constructing Quartermaster

In designing sewage disposal plants for Army camps, engineers are taking advantage of all that has been learned since World War I. Many diseases were prevalent at that time, when much less was known about the results of improper sanitation. The plants now being built represent a great technical advance and at the same time meet the rather special needs of an Army camp, which has a load pattern basically different from that of a civilian or industrial installation.

From experience gained in World War I, and from scientific research and experience since then, sanitary engineers have greatly developed the science of sewage disposal for Army camps. They have vastly improved upon the mere "sewage tank" that was common in the 1918 camps throughout the nation. Many diseases were prevalent during that period when men were thrown together hastily from varied walks of life. Since then the engineers, working with the doctors, have found that many diseases were transmitted through improper sewage disposal as well as through improper sleeping conditions.

Thus, when the present emergency came, the engineers and army builders were more capable of handling the problem of preventing diseases due to mass living. Sewage disposal was a factor on which they had some definite figures and information.

Special Considerations Govern

In designing such a disposal plant, the first essential was to determine the extent of treatment necessary in each case. An army is a different problem from a city of the same population. In cities people come and go at all hours of the day, and the various industries use water and produce sewage continually while the people are working. The army operates on a schedule, so that when one man works, all work. This means that when "recall" is sounded in the evening practically every person who makes up the population of the camp wants to take a shower bath within the next half hour. Thus the design factors had to be arrived at in an entirely different manner from those for a city of the same "population."

Of prime interest to many people when considering the work of the army is the means of operating such a plant, and attendant utilities, in the vast camps and cantonments. The policy of the War Department to use men not eligible for military duty to maintain and operate utilities is carried out in the realm of sewage disposal. The camp has a commissioned officer as a Utilities Officer, with one or more commissioned assistants, depending upon the needs of the camp in question. Everyone working under these officers is from civil service lists. No soldiers are used on such jobs. The number of jobs and the rate of pay of each are established by authorities higher than those in the individual camp. The camps therefore endeavor to secure men who know something about sewage disposal plants and their operation.

Camp in Form of a Semicircle

With this as a preliminary to an understanding of the problems, let us consider one particular army camp of today. This camp is one of the largest in the country, and entirely new; it was not built as an extension to some existing facility. In this case, a Southern camp, it was found that the sewage would eventually be emptied into a stream with low flow. This meant that the sewage required some definite form of treatment.

The camp is built in the form of a half circle, around the edge of a circular lake, with the disposal plant near the center of the outside rim. The ground slopes away from the lake in all directions; one small stream runs out of the lake but none run into it. After circling around for a couple of miles the stream returns to a point near the back of the camp, that is, at the outer rim of the circle. Here the disposal plant is located alongside the stream, which oftentimes is dry. Some distance downstream this dry run empties into a larger stream which is always flowing.

More than 79 miles of sewer lines feed into the disposal plant, serving 55,000 men throughout the camp. The sewage has to flow a maximum of about two miles to get to the plant. In the process, three pumping stations, each fully automatic, are used to lift the sewage so that it will flow over the "humps" and into the plant by gravity. Of course a large area feeds by gravity direct to the plant.

Mechanical Handling

In the treatment process the first step is to restrict the flow of the sewage and pass it through a Parshall flume, or measuring device. During the spring and early summer of 1941, it amounted to about 110 gal per day per man, or a total of over four million gallons per day. At night this drops to about 1,000 gal per min, while during the evening, around 6 p.m., the flow will rise to more than 6,000 gal per min—at the rate of more than 8,600,000 gal per day.

After measurement, the sewage flows past some straightening vanes which widen out the stream and thus slow it down as it enters the detritor. This again widens the flow to about 15 ft. At the reduced velocity the heavier particles, such as sand, rocks, and rags, drop out. This grit is dragged to one side by a revolving rake along the bottom, then pushed by another rake along the side and out into a box so that it can be hauled away. A small motor-driven pump near the center of the second rake helps draw the grit into the rake channel. Any organic matter drawn in is washed back into the detritor proper, thus cleaning the grit. Rags tend to collect on the impeller and must be removed two or three times a day. Underwear and towels are the main source of trouble; other items found are pants, shirts, and socks.

As the sewage flows out of the detritor tank and through a channel, it strikes a revolving cutter, called a comminutor, which tears the larger particles into bits and grinds up the sewage so that it can be readily mixed with water. No particles leave here until they are broken down to a maximum dimension of less than 1/4 in. There are two of these machines, which can be operated

alone or in parallel. Their motors are out in the open air, exposed to the elements. Actually the comminutor basin is an integral part of the Parshall flume—that is the entire detritor-comminutor structure is of monolithic concrete, as shown in one of the views. Built-in by-passes around each mechanism make the entire structure quite flexible in operation.

CHLORINE TREATMENT PROVIDED

The sewage, after being torn to bits in the comminutors, is emptied into a single compartment having three outlets controlled by gate valves. One is a 30-in. pipe leading to the final discharge manhole, thus allowing the remainder of the plant to be by-passed. Then there are two 24-in. pipes more than 100 ft long leading to the clarifiers and used as pre-chlorination chambers.

Sufficient chlorine gas is added to hold down the odor, but no attempt is made to kill bacteria as this would be entirely too expensive. Actually, about 2 ppm is fed in. The gas has a reaction time equal to the time required for the flow from the comminutors to reach the clarifiers. There the sewage is allowed to stand exposed to the air and possibly most of the gas evaporates. In any event, odors have not been noticed.

Leaving the gas chamber, the sewage enters the center of the settling tank, near the top, having come up from the bottom through a vertical pipe. It then flows down under a baffle, then up again and to the outside of the tank, which is 70 ft in diameter. As it approaches the rim of the tank, the flow gets slower and slower, and its ability to carry solids grows less and less, so that the solids drop to the bottom.

By this time the flow over the rim has lost 98% of its original solids. In another chlorine chamber 7 or 8 ppm of chlorine is added, sufficient to kill a large number of bacteria and to some extent sterilize the liquid. This chamber is more than 7,200 ft long, giving a flow-through period or reaction time of 22 minutes; it discharges direct into a stream with a normal flow five or six times the sewage flow, even in dry weather.

SLUDGE IS EFFICIENTLY HANDLED

With the help of a mechanical rake, solids in the settling tank work to the center or low point. There the sludge falls into a hopper and is pumped by means of one or both of two diaphragm pumps into a large concrete tank or digester.

For satisfactory operation the pump has to be started, and the sludge in the clarifiers moved, at least once every hour; it must start slowly so as not to create a violent pull on the sludge. The ball valve on the pump is frequently taken out for cleaning. The pumps are located in a pumphouse on level ground so that the lift actually is about $1^1/_2$ ft above the water line in the tanks. The sludge is forced some 15 ft higher into the digesters. At times, especially during the night, the pumps need to be operated for only five minutes to remove the settled sludge; but sometimes it is necessary to operate them continuously. One pump running continuously is found to be better than a quick discharge with two pumps. As soon as the sludge discharge begins to thin, the pump is stopped, to be started again on the hour. When the sampling cock on the discharge shows no flow, the ball valves usually are found to be clogged with rags, and it is a matter of only a couple of minutes to remove them.

The pump discharge may be sent to the digesters or to the raw sewage line. Actually, the water in the bottom of the scum pit is usually returned to the raw sewage until the scum is drawn down sufficiently to get rid of a large amount of settled water, at which time the valves are changed to pump the scum floating on the clarifiers into the digesters. Since the amount of pumping depends entirely upon the way the scum weir is set, this weir should be set very accurately. Wind has been found to effect the amount of water in the scum pit. One of the weirs was at first set too low and this resulted in a great amount of water being blown into the pit, thus necessitating much pumping. However, a strip of steel was welded to the weir, raising it enough to keep out everything except what was pushed over it by the scum rake.

A CORNER OF THE PLANT, WITH PARSHALL FLUME AT RIGHT, THEN DETRITOR AND COMMINUTORS
Mechanism for Raking Out Detritor in Foreground

THROUGH THE DIGESTERS

Digesters are 50 ft in diameter and 20 ft deep. Two are primary tanks, with fixed steel domes, operating in parallel, singly, or together. The gas collected is led by means of an open channel, without fencing, to the third, or center, digester, of the same size but with a floating steel dome for holding gas. A relief valve is set to release at 6 in. of pressure. This means that there is a head of 6 in. (water pressure) on the gas leaving the tanks.

Mechanical agitation is provided in the two primary tanks to break up the scum and move the solids. This consists of a slow-moving impeller in the center. Sludge enters the primary tank at an angle, giving the contents a rotary motion, in the direction of agitation, and forcing an equal amount of settled liquor over the top and into the raw sewage line. Or, at the will of the operator, it may be forced into the secondary tank if it is felt that foam or floating solids should be further settled.

Sludge from the bottom may be directed either onto the drying beds or into the secondary tank. In fact

the whole digestion system is so arranged, by means of a system of piping, that sludge may be drawn from the bottom, top, or middle of any tank and forced to the bottom, middle, or top of any other tank, or may be put back into raw sewage or onto the drying beds. The three digesters are spaced in line, with a small room between, containing all control valves, piping, sampling cocks, and testing means. Automatic exhaust fans are placed on the floor of each of these headhouses set to operate 15 min, then to be off 15 min, thus guarding against leaking gas. All equipment has spark-proof wiring and switches.

THE THREE DIGESTION TANKS—SANDY SOIL TYPICAL OF THE AREA APPEARS IN FOREGROUND

Considerable difficulty was experienced at first in bringing the pH of the sludge in the digesters up to standard; however, very little foaming was noticed. Lime was added in quantities up to 2,000 lb per tank per day by mixing in milk of lime and putting it in the scum pit, then pumping to the digesters. Later a much better effect was obtained by adding the milk of lime to the top of the digesters through the roof. When the lid was opened the gas was lost, but until the pH value rose there was very little gas production and its loss was of no consequence. Lime added on top of the crust seemed to settle it and help considerably in breaking it up.

Heating coils are a standard part of these digesters but at present are not used, thanks to the Southern climate. Although the tanks were placed in operation during the latter part of December 1940, the amount of sludge at first was not great, and it was possible to leave it in the digesters for some time. Thus by the time the tanks were full and more space was needed, warmer weather had come and the sludge had created its own heat to such an extent that further heating was not necessary.

THEN TO SLUDGE BEDS

Twenty-four sludge beds are provided, each with an area approximately equal to that of one digester. Thus, the exact drawdown in the digester is easily determined by watching the depth of sludge in the bed being filled. All sludge is drawn by gravity. The sides of the sludge beds are of native sandy soil, riprapped with brick secured from an old National Guard camp and slushed with cement paste, thus providing a solid surface. At first no surfacing was intended, but semi-tropical rains in this vicinity, together with sandy soil, made protection necessary. The outside of the sludge-bed banks is heavily sodded to prevent erosion.

It will be noted that throughout this plant sewage flows by gravity. There are three booster stations in the sewage line at widely scattered points; however none forces sewage into the plant proper. The only pumping in the plant is done when sludge is lifted from the clarifiers into the sludge digestion tanks, or when for some special reason it is transferred from one tank to another.

A gas-pressure regulator and flame trap are provided, through which the sewage gas is fed to the burner. At present no use is made of the gas, although some 40,000 cu ft is produced daily. A 1,200-ft pipe line to feed the gas to a boiler for the camp laundry may be laid later. However, as maneuvers make the supply of sewage rather uncertain, the utilization of the gas is problematical.

RESULTS OF EARLY TREATMENT

A control house, with office and laboratory, houses the electrical panel, which controls all motors throughout the plant. It is equipped with alarm bells which ring when certain motors are stopped for any reason whatever. This control house contains the flow meter, a part of the Parshall flume equipment, which shows the rate of flow and the total flow. Also provided are electric meters which aid in determining the exact costs of treatment by showing the current actually used. Provisions are being made for a complete chemical analysis.

Samples are taken throughout the plant at frequent intervals and run through the laboratory so as to provide a definite record of the exact nature of army-produced sewage. Never before has such a complete record been possible in a highly specialized group such as an army. Such data as are obtained at this and other camps will provide the first definite figures of this sort that have ever been collected.

An analysis taken in May 1941, when the flow was averaging more than 4,000,000 gal per day, shows the following content for a 7-day average:

Total solids	396 ppm
Ash	118 ppm
Suspended solids	155 ppm
Suspended solids ash	17 ppm
B.O.D.	106 ppm

Minor equipment at the plant includes a rubber-tired truck, raised and lowered hydraulically, which is used on the concrete walkway to carry one-ton drums of chlorine from the storage rack to the scale platform from which it is fed. A car containing 15 tons of chlorine is purchased and stored on the open rack at one time, provision being made for handling a total of more than 40 drums.

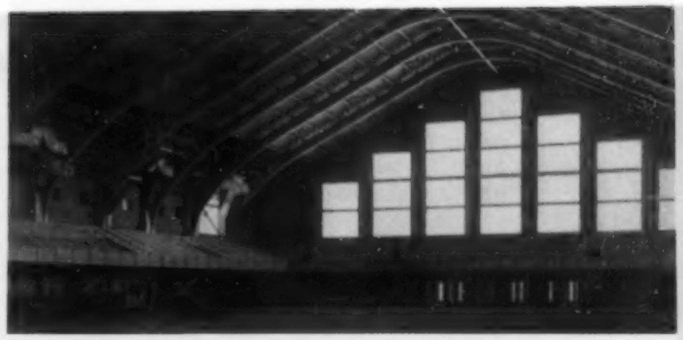
All structures, including the office-laboratory, pump house, chlorine house, digesters, and detritor, are built of concrete. The buildings are of concrete blocks, and the tanks are of reinforced concrete. In all respects the sanitary utilities of this camp are of a permanent nature, and incorporate all the best elements of present-day good design. Nothing is built on a flimsy or makeshift pattern. Although this camp, like all the others, is said to be of "temporary" construction, the sewage plant is built the one and only way for good performance—the right way.

Measured Stresses in a Two-Hinged Beam Arch

Stresses in Completed Building Compared with Those Computed in the Design

By P. E. Soneson, Assoc. M. Am. Soc. C.E.

Assistant Professor, Architectural Engineering, Purdue University, West Lafayette, Ind.



Interior View of Field House Shows Hinged Arches in Relation to the Balcony

Engineers are always interested in comparisons between design assumptions and the actual behavior of the completed structure. In this article Professor Soneson describes measurements of stresses in a typical two-hinged beam arch of the Purdue University Field House, as compared with the computed design stresses. The unit stresses were measured along the leg and knee of a steel beam arch which supports a quarter-pitch roof and a spectators' balcony, adding a live load to the picture. Results, here given in some detail by Professor Soneson, show the difference between the expected and the actual behavior of this large steel structure.

Early in 1937 it was suggested to the writer that he investigate the behavior of the beam arches of the Purdue Field House, the construction of which had just begun. Arrangements were made with the building contractor and the research was planned as a joint project of the Engineering Experiment Station and the Purdue School of Civil Engineering. The program of research embodied several items, of which the following are dealt with in this article:

1. Placing of stations and taking of extensometer readings on two arches before erection.
2. Taking of extensometer readings when the building was completed.
3. Taking of extensometer readings when a full audience was on the balconies.
4. Comparison of measured and computed unit stresses as a check on the design method.

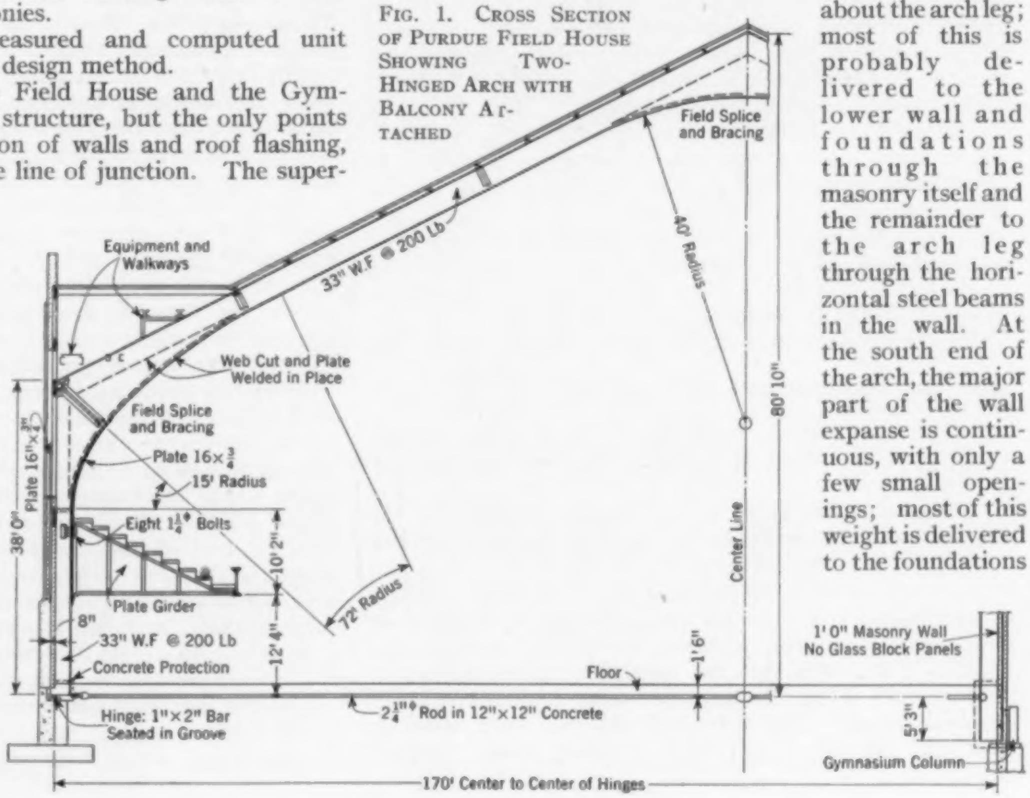
From the outside, the Field House and the Gymnasium appear to be one structure, but the only points of contact are the junction of walls and roof flashing, and the footings along the line of junction. The superstructure of the Field House is thus permitted to follow its own course of action, since the influence of these connections is too slight for the bulk of the Gymnasium to restrain the action of its neighbor.

The Field House is 173 ft by 303 ft, with side walls 52 ft above grade and end walls 84 ft high at the peak. The masonry walls are trimmed with stone, and large areas of glass blocks admit light to the interior. The supporting structure is a frame of steel members, the most prominent being 12 beam arches of 170-ft span, spaced 23 ft 1 in. on centers. Details of the design appear in Fig. 1.

The beam arch is a patented form of the two-hinged arch and is fabricated from rolled steel sections into a neat arch form with an "I" cross section of varying depth. Where extra depth of cross section is needed, the inside flange is slit away from the web, and bent from it to form the desired curve of arch contour; a piece of plate is then welded to the separated edges to provide a continuous web. The turnbuckles of each tie rod were turned until the rod became fairly taut when jumped upon and until the hinge bar in the bearing plate slot was released from contact with the side of the slot. The hinge is made of a steel bar, 1 in. by 2 in., welded on the bottom of the arch-leg base and fitting in a slot in the steel bearing plate anchored to the concrete pier. For protection, a mass of concrete was poured around each arch leg from top of pier to 6 in. above ground and 3 in. beyond the steel arch leg in all directions.

At both ends of the arch, the exterior masonry walls are built so as to enclose the outer flange of the arch leg, with 8 in. of the wall thickness extending inside the face of the flange. Although a masonry wall is slightly elastic, this tight connection undoubtedly prevents the arch from acting freely. The weight of masonry above the glass-block panel (in the north wall) is delivered to the pier of masonry about the arch leg; most of this is probably delivered to the lower wall and foundations through the masonry itself and the remainder to the arch leg through the horizontal steel beams in the wall. At the south end of the arch, the major part of the wall expanse is continuous, with only a few small openings; most of this weight is delivered to the foundations

Fig. 1. Cross Section of Purdue Field House Showing Two-Hinged Arch with Balcony Attached



through the masonry itself, although some small portion adjacent to the arch leg might act as a vertical load on the outer flange of this leg.

The balcony is supported by plate girders (with sloping upper flange) attached to the inner flange of each arch leg by a pair of vertical angles along the full depth of the connection and by a group of eight $1^1/_4$-in.-diameter bolts near the top of the balcony girder. This group of bolts is intended to resist the horizontal tendency of the upper part of the connection to separate from the flange of the arch leg.

Design of the Purdue Field House was made in the office of Walter Scholer, architect of Lafayette, Ind. The computations, made by M. E. Norman, of the American Bridge Company, Chicago, and the consultant, C. A. Ellis, M. Am. Soc. C.E., were made available to the author.

The original design was made by using a diagrammatic outline of the arch span and considering the moment of inertia of the cross section as constant. The tie rod under the floor, connecting the two legs, sets the horizontal reactions at the same level and allows the vertical reactions to be statically determinate. The horizontal reaction was secured by applying $\Delta x = \int \frac{Myds}{EI} = 0$, in which Δx = horizontal movement of left hinge, M = bending moment at a section, y = vertical distance from left hinge to a section, ds = an increment of length measured along the arch outline, E = Young's modulus of elasticity, and I = moment of inertia of a cross section. Values for shear, bending moment, and thrust at various sections then could be computed easily. The unit stress caused by bending was recognized as the dominant effect, and a curve of the bending moment was made to assist in choosing a definite size of rolled I-beam for the arch in general. This was drawn in place, flange plate added on the legs, where additional resisting moment was required, and the web expanded at the peak and at both knees by curving the interior flange contour to make a graceful, and at the same time a stronger, corner junction.

This original design was checked by dividing the chosen arch into segments and applying $\Delta x = \sum \frac{Myds}{EI} = 0$ to secure the value of the horizontal reaction for various loadings of dead load, live load on the balcony, and live load on the roof.

Terms are the same as previously explained; the center line of the arch rib was used as the arch contour and each cross section was cut at right angles to this contour of the arch rib center line. The value of I was computed according to the area and depth of the cross section thus secured. Shears, bending moments, and thrusts were calculated for several cross sections, and unit stresses in the flanges were computed to check the original design. The total unit stresses were taken as the sum of the axial and bending unit stresses: $s = P/A + Mc/I$.

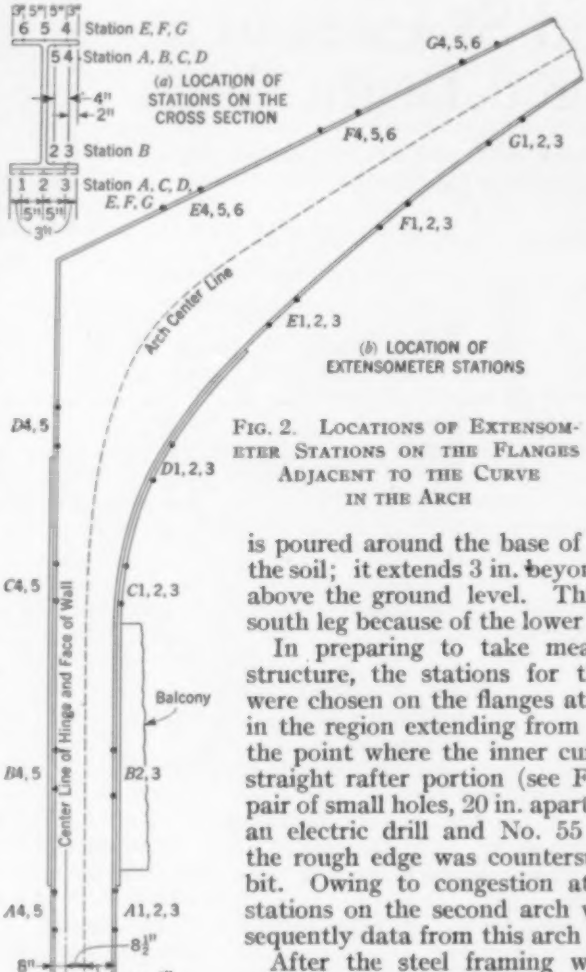


FIG. 2. LOCATIONS OF EXTENSOMETER STATIONS ON THE FLANGES ADJACENT TO THE CURVE IN THE ARCH

The design procedure is for a free-standing, two-hinged arch, but the plans and the construction show several items that depart from this simple condition. They are the following:

1. The exterior flanges of the beam arch legs are embedded 8 in. in the exterior masonry walls.

2. The hinge at the south end of the arch is 5 ft 3 in. lower than at the north end. The tie rod is horizontal and is attached to the south leg 5 ft 3 in. above the hinge.

3. A block of concrete is poured around the base of each leg to protect it from the soil; it extends 3 in. beyond the steel and about 6 in. above the ground level. This casing is larger at the south leg because of the lower base.

In preparing to take measurements on the actual structure, the stations for the extensometer readings were chosen on the flanges at both ends of two arches in the region extending from just below the balcony to the point where the inner curve of the knee meets the straight rafter portion (see Fig. 2). Each station is a pair of small holes, 20 in. apart along the arch, made with an electric drill and No. 55 bit (0.052 in. diameter); the rough edge was countersunk slightly with a larger bit. Owing to congestion at the unloading area, the stations on the second arch were not completed; consequently data from this arch are not included here.

After the steel framing was in place, two sets of wooden steps, previously designed and fabricated, were suspended from the roof beams in a position to give access to the extensometer stations for later observations. These steps were demountable and were moved from one arch to another as desired.

The full dead-load readings on both arches were taken with the same extensometer after the building was entirely completed. The temperature of the steel at each station was secured by taping thermometers to the steel surface for a period of at least fifteen minutes.

In a similar manner the extensometer readings for dead load plus balcony live loads were taken during basketball games when the audience filled the balcony. The audience prevented the use of the stations just above the top of the balcony (Sta. C, Fig. 2). In general the audience stayed in their seats and the impact effect, if any, was very small.

The original readings were taken on the steel as it lay in the open and the temperature varied from 30 to 35 F. These constitute the zero load conditions with which later readings were compared. The later readings were taken inside the finished building at temperatures ranging from 55 to 80 F. A basic temperature of 60 F was selected, and all readings were adjusted for the change in length of the steel within the 20-in. reach of the extensometer. The coefficient of expansion for steel was taken as 0.0000067, and the modulus of elasticity as 29,000 kips per sq in. The instrument constant was 4.51.

Unit stresses were computed from the difference between the corrected extensometer readings, as follows:

$$\text{Unit stress} = \frac{\text{Difference}}{4.51 \times 20} \times 29{,}000 \text{ kips per sq in.}$$

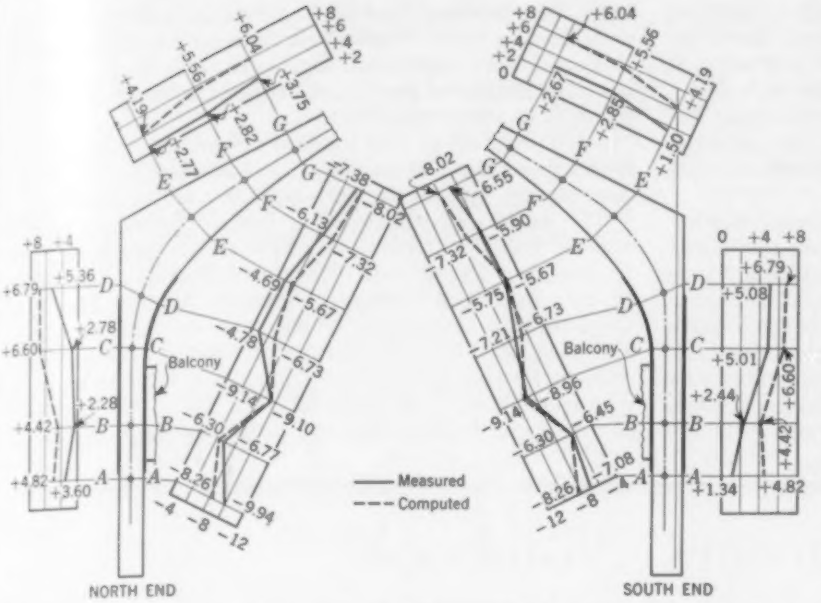


FIG. 3. COMPARISON OF MEASURED AND COMPUTED DEAD-LOAD STRESSES ONLY

The measured unit stresses are the average of five series of observations at both ends of the arch under corresponding conditions of load. The computed unit stresses are the sum of the stresses due to axial thrust (P/A) and the bending stresses (Mc/I) at the fibers where the extensometer stations are located.

In Fig. 3 the computed and measured unit stresses (dead load) are compared. The two ends of the arch do not yield identical results but their general behavior is similar. On the exterior flanges the measured stresses are much lower than the computed, averaging 63% of the latter in the north leg and 60% in the north rafter, 59% in the south leg and 44% in the south rafter. On the interior flange the measured stresses are much nearer the computed but no definite pattern is present. At Sta. C the stresses are high and agree quite well; just below is the balcony connection with its rather indeterminate load transfer, and above Sta. C is the curved flange spliced at the knee. Erection stresses may account for some of the variation between similar points at the north and south ends. The most serious disagreement is at Sta. A on the north end, where the measured stress exceeds the computed by 20%; note that this is the largest measured stress at either end.

The difference between the comparative behavior of the outer and inner flanges appears to be quite definite; the outer flange seems to be somewhat "restrained," with stresses less than the computed, while at the inner flange the measured stresses more nearly agree with the computed values, being larger at some points and smaller at others. The author feels that the masonry wall (around the outer flanges up to the knee) is preventing the arch from behaving freely, as the design stresses expect it to do. If this is true the removal of the wall restraint would result in higher flange stresses, so that at several points on the inner flange the actual stresses would exceed the computed considerably.

From one point of view it might appear that some of the exterior wall weight should be considered as a load applied on the exterior flange of the arch legs. This would increase the compression stresses and serve to decrease slightly the gap between the measured and the computed stresses in the exterior flange of the arch legs. But this load would distribute, in some manner, over the arch leg cross section and increase the computed compression stresses in the interior flange also. This might be justified as bringing the measured and computed unit stresses more nearly into agreement, but the amount of the load and its true influence upon the stresses in the arch leg could be only a guess.

The computed stresses due to an audience on the balconies are the opposite of the dead stresses, except for the stations under the balconies. The load on the balcony is seen as tending to rotate the arch legs inward and thereby to decrease the effect of the dead load.

In Fig. 4 the computed and measured unit stresses are compared. Measured stresses at Sta. C are not available because the audience prevented access to these stations.

As in the case of the dead load, the measured stresses along the exterior flanges are less than the computed but the relation between them has altered; none of these are high in amount or important in the design. On the interior flange the measured stresses exceed the computed at 8 out of 12 places, ranging from 81% to 126% of the latter. For this load condition the measured stresses are a larger percentage of the computed stresses than for dead load. It thus appears that the added live load is not causing the expected opposite stresses; instead of causing tension stresses on the interior flange above the balconies, the audience load is causing more compression, that is, it is adding to the dead-load stresses.

These balcony live-load stresses are not large but they indicate that the arch behavior under this load is not according to expectations. It is noted that at both ends, for stations above D on both flanges, the balcony live load causes compression stresses, probably because the inward rotational effect of the balcony load tends to

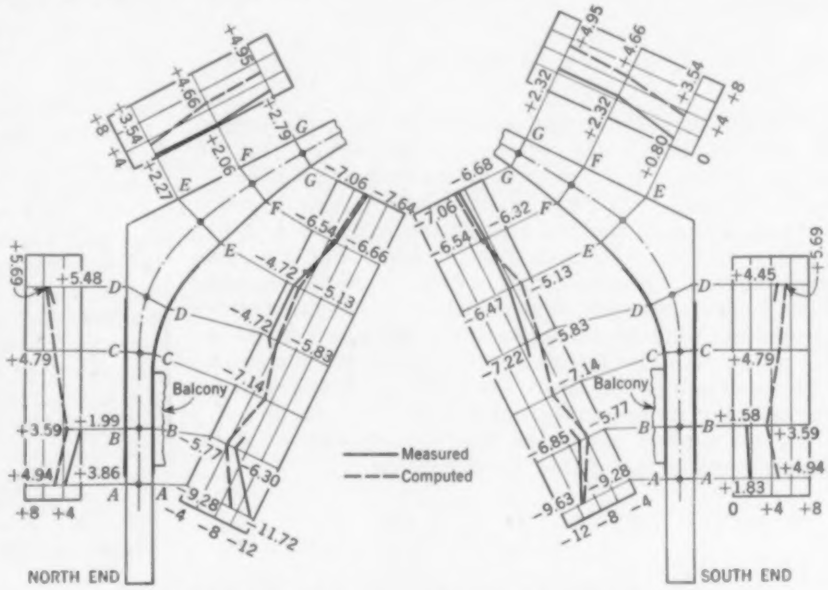


FIG. 4. COMPARISON OF MEASURED AND COMPUTED STRESSES FOR DEAD LOAD AND BALCONY LIVE LOAD

bend the knee, as a whole, into a more nearly straight line instead of bending each cross section like a beam.

From these measured strains the author believes that the following general conclusions may be drawn:

1. The general design procedure of considering the arch free from the several restraints of the adjacent construction does not lead to serious discrepancies between computed and actual stresses.

2. The exterior masonry wall built around the exterior flange of the arch leg serves to restrain the elastic action of the arch and thus to prevent the interior flange stresses from seriously exceeding the computed values.

3. The inner flange stresses more nearly agree with the computed values than the exterior flange stresses do; if the arch were "free standing," as the design procedure usually considers it to be, the interior flange stresses might exceed the computed values considerably.

4. The balcony load effect tends to "straighten" the arch knee or bend it more nearly toward a straight line; this produces compression stresses in both flanges around the knee instead of tension in the interior flange and compression in the exterior flange.

5. The effect of roof loads is far greater than that of balcony loads; the balcony live-load stresses could be disregarded without danger since they are so small.

The author wishes to acknowledge the valued assistance of the Department of Physical Education and the Engineering Experiment Station of Purdue University, of the American Bridge Company, of the Ben Hur Construction Company (whose men erected the steel), and of R. E. Mills, Assistant Professor of Testing Materials at Purdue University. The kind interest and encouragement of C. A. Ellis, M. Am. Soc. C.E., Professor of Structural Engineering at Purdue, are appreciated.

Engineers' Notebook

Ingenious Suggestions and Practical Data Useful in the Solution of a Variety of Engineering Problems

The Kinetic Energy and Momentum Correction Factors for Pipes and for Open Channels of Great Width

By VICTOR L. STREETER, ASSOC. M. AM. SOC. C.E.

ASSOCIATE PROFESSOR OF CIVIL ENGINEERING, ILLINOIS INSTITUTE OF TECHNOLOGY, CHICAGO, ILL.

As the velocity of flow over a normal cross section generally varies from point to point, the velocity head determined from the mean velocity V cannot represent the true mean kinetic energy per pound of fluid unless multiplied by a correction factor K_e. That is, not only does the square of the average velocity differ from the average square, but the local velocity head $v^2/2g$ must in addition be weighted according to the relative number of pounds passing each element of area per unit time. K_e therefore may be evaluated from the expression

$$K_e \frac{V^2}{2g} = \frac{1}{VA}\int^A \frac{V^2}{2g}\, v\, dA \text{ or } K_e = \frac{1}{A}\int^A \left(\frac{v}{V}\right)^3 dA$$

in which V is the average velocity for the cross section of area A, and v the velocity corresponding to the elemental area dA. The integral is taken over the cross-sectional area. Although K_e is usually taken as unity in the solution of problems arising in hydraulics, it has a value of 2.0 for laminar flow in pipes; and for cases where there is separation, that is, in an expanding section, it may have values much greater than 2. Serious errors in analysis may be introduced, therefore, by assuming the value of unity for all cases of flow. Similarly the momentum obtained from the average velocity is not the average momentum, and a correction factor, K_m, must be applied when the average velocity is used. This correction factor may be defined as

$$K_m = \frac{1}{A}\int^A \left(\frac{v}{V}\right)^2 dA$$

A study of the magnitude of K_e and K_m for turbulent flow in pipes and in extremely wide channels was made by the writer as a special problem during the national defense course in mechanics of fluids given by Prof. Hunter Rouse at the University of Iowa in June 1941. This study consisted of the determination of K_e and K_m from the von Kármán universal logarithmic velocity distribution law ("Turbulence and Skin Friction," *Journal of Aeronautical Science*, 1934, Vol. 1, No. 1).

$$\frac{v}{\sqrt{\tau_0/\rho}} = 5.5 + 5.75 \log_{10} \sqrt{(\tau_0/\rho)(y/\nu)} \quad \ldots\ldots (1)$$

in which v is the velocity at the distance y from the boundary; τ_0 is the shear of the boundry; ρ is the mass density of the fluid; and ν is the kinematic viscosity of the fluid. As the derivation of Eq. 1 was based on the assumption that the velocity distribution near the wall (excluding the laminar boundary film) is a function of τ_0, ρ, ν, and y, it should be equally applicable to pipes or extremely wide channels in which secondary flow does not occur. Although the derivation was for conditions near the wall, experiments show that the formula holds good beyond this range and that it can be extended to the center line of a pipe. It should be noted in Eq. 1 that when y approaches 0, v approaches $-\infty$. Hence the equation should be considered to apply only from the distance y at which $v = 0$ to the center of the pipe or the free surface for open channels.

Integration of Eq. 1 for circular pipes results in

$$\frac{V}{\sqrt{\tau_0/\rho}} = 1.75 + 5.75 \log_{10} \sqrt{(\tau_0/\rho)(r_0/\nu)} \quad \ldots (2)$$

where r_0 is the radius of the pipe. Subtracting Eq. 1,

$$\frac{v - V}{\sqrt{\tau_0/\rho}} = 3.75 + 5.75 \log_{10} \frac{y}{r_0} \quad \ldots\ldots\ldots (3)$$

Equilibrium conditions in the pipe, for steady flow, require that

$$\tau_0 = -\frac{r_0}{2}\gamma\frac{\Delta h}{\Delta x} \qquad (4)$$

in which $-\frac{\Delta h}{\Delta x}$ is the hydraulic gradient, or rate of change of head with length along the pipe, and γ is the unit weight of fluid. From the Darcy-Weisbach formula,

$$-\frac{\Delta h}{\Delta x} = \frac{f}{2r_0}\frac{V^2}{2g} \qquad (5)$$

where f is the resistance coefficient. Eliminating $-\frac{\Delta h}{\Delta x}$ from Eqs. 4 and 5,

$$\sqrt{\tau_0/\rho} = V\sqrt{f/8} \qquad (6)$$

and by eliminating $\sqrt{\tau_0/\rho}$ in Eqs. 3 and 6, expressing the logarithm to the base e, and rearranging,

$$\frac{v}{V} = 1 + 3.75\sqrt{f/8} + 2.5\sqrt{f/8}\log_e\frac{y}{r_0} \qquad (7)$$

This expression has been used in the advanced fluid mechanics courses taught by Professor Rouse.

From Eq. 7, K_e may be evaluated as a function of f by substitution in the equation

$$K_e = \frac{1}{A}\int^A \left(\frac{v}{V}\right)^3 dA \qquad (8)$$

Performing the integration,

$$K_e = 1 + \frac{3.75}{16}\frac{f}{8} - \frac{1,125}{32}(\sqrt{f/8})^3$$

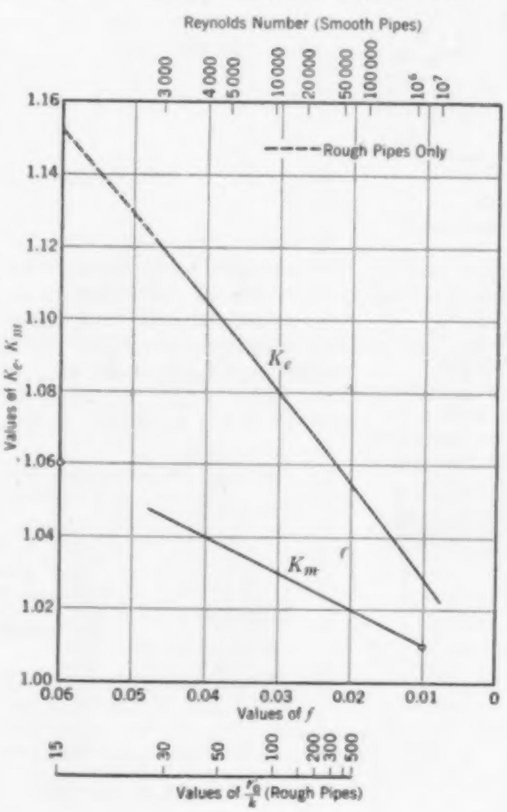
Figure 1 shows the graph of K_e as a function of f, the Reynolds number for smooth pipes, and the Nikuradse relative roughness r_0/k. The relationship between f and the Reynolds number is the von Kármán universal law of resistance for smooth pipes,

$$\frac{1}{\sqrt{f}} = -0.8 + 2\log_{10}(R\sqrt{f})$$

where $R = 2Vr_0/\nu$. The relationship between f and r_0/k was obtained from the experimental data of J. Nikuradse ("Strömungsgesetze in rauhen Rohren," V.D.I. *Forschungsheft* 361, 1933):

$$\frac{1}{\sqrt{f}} = 1.74 + 2\log_{10}\frac{r_0}{k}$$

FIG. 1 GRAPH OF K_e AND K_m FOR PIPES



in which k is the diameter of the uniform sand grains used by Nikuradse to roughen the interior of the pipes.

Following the same procedure as for circular pipes, K_e for open channels may be expressed analytically as a function of f, C, or $y_0^{1/6}/n$, in which C is the Chezy coefficient and $y_0^{1/6}/n$ is the Manning relative roughness. The graph is shown in Fig. 2.

Integration of Eq. 1 for an extremely wide channel to obtain the average velocity, V, results in

$$\frac{v}{V} = 1.0 + 2.5\sqrt{g/C} + 2.5\sqrt{g/C}\log_e\frac{y}{y_0} \qquad (9)$$

which is the velocity distribution for a wide channel in terms of the average velocity, V, the Chezy coefficient C, and the depth y_0; y is the distance from the bottom of the channel to the point having a velocity v. Substituting Eq. 9 in Eq. 8, and performing the integration,

$$K_e = 1 + \left(\frac{75}{4}\right)\left(\frac{g}{C^2}\right) - \left(\frac{125}{4}\right)\left(\frac{g^{3/2}}{C^3}\right)$$

Figure 2 shows the graph K_e as a function of C, f, and $y_0^{1/6}/n$.

It is to be noted that K_e is smaller in channels than in pipes for the same value of f. In both cases K_e approaches unity for decreasing values of f. For established flow in channels of finite width, the value of K_e will probably lie between those for the pipe and for the very wide channel, for the same values of the resistance coefficient.

In an analogous manner the momentum correction factor for pipes is

$$K_m = 1 + \frac{125}{128}f$$

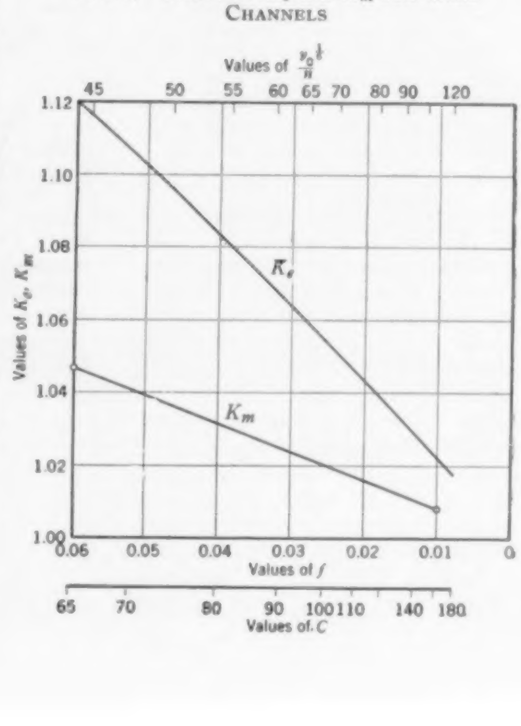
For extremely wide channels,

$$K_m = 1 + \frac{6.251}{C^2}g = 1 + 0.781f = 1 + 2.83g\frac{n^2}{y_0^{1/3}}$$

These curves are also shown in Figs. 1 and 2.

Where there is no reversal of flow in a cross section, K_m will always be smaller than K_e for a given velocity distribution, and K_e tends to approach K_m as the velocity distribution tends to become uniform.

FIG. 2. GRAPH OF K_e AND K_m FOR WIDE CHANNELS



Thrust and Symmetrical Bending in Reinforced Concrete

By STANLEY U. BENSCOTER, JUN. AM. SOC. C.E.
U.S. ENGINEER OFFICE, VICKSBURG, MISS.

THE complete stress analysis of a given concrete section with an eccentric load requires a computation of existing stresses and also a computation of the maximum allowable stress in the concrete. The 1940 Joint Committee Specifications for Reinforced Concrete (PROCEEDINGS, Am. Soc. C.E., June 1940, p. 73) present a logical formula for determining the allowable stress.

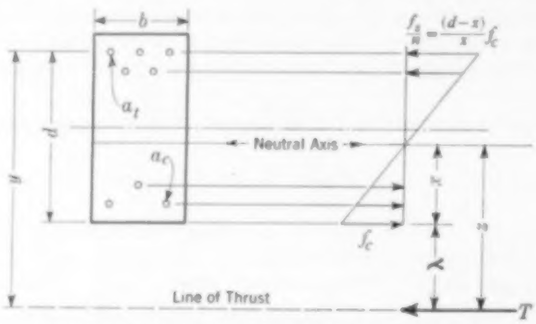


FIG. 1. INTERNAL STRESS DISTRIBUTION

This formula requires a computation of the area of the transformed section and its moment of inertia about its centroidal axis. In designing many sections subjected to thrust and bending the writer has evolved, for the case of symmetrical bending, a manner of writing down the computations so that the complete stress analysis can be placed on one computation sheet. The following notation is used:

- a = transformed area of a bar
- a_c = actual area of a compression bar
- a_t = actual area of a tension bar
- A, B = constants in cubic equation
- b = width of beam (or slice of a slab)
- c = distance from centroid to maximum compressive fiber
- C = ratio of allowable stress in a column to the allowable stress in a beam
- d = distance from a bar to the maximum compressive fiber
- e = eccentricity of thrust from centroid
- e' = eccentricity of thrust from center line
- f_a = allowable stress in a concentrically loaded column
- f_c = maximum compressive fiber stress
- f_e = allowable stress in an eccentrically loaded column
- f_s = maximum tensile steel stress
- i, I = moment of inertia
- M = moment
- n = modular ratio
- R = radius of gyration
- T = thrust
- x = distance from neutral axis to maximum compressive fiber
- y = distance from a bar to the line of thrust
- z = distance from neutral axis to line of thrust
- λ = distance from maximum compressive fiber to line of thrust

Referring to Fig. 1, we may apply the equilibrium conditions $\Sigma H = 0$ and $\Sigma M = 0$ to obtain, respectively,

$$\frac{bxf_c}{2} + (n-1)\Sigma a_c \frac{(x-d)}{x} f_c - n\Sigma a_t \frac{(d-x)}{x} f_c - T = 0 \qquad (1)$$

$$\frac{bxf_c}{2}\left(\frac{x}{3} + \lambda\right) + (n-1)\Sigma a_c \frac{(x-d)}{x} f_c y - n\Sigma a_t \frac{(d-x)}{x} f_c y = 0 \qquad (2)$$

Equation 2 is obtained by taking moments about the line of thrust. As is well known, this equation becomes a cubic in x when cleared. For conveniences that will become apparent, make the following substitution in Eq. 2,

$$x = z - \lambda \qquad (3)$$

This gives a cubic in z,

$$\frac{b}{6}(z^3 - 3\lambda^2 z + 2\lambda^3) + z\Sigma ay - \Sigma ay\lambda - \Sigma ayd = 0 \qquad (4)$$

Notice that

$$\Sigma ay\lambda + \Sigma ayd = \Sigma ay(\lambda + d) = \Sigma ay^2 \qquad (5)$$

Introduce the following definitions:

$$M = \Sigma ay \qquad (6)$$

$$I = \Sigma ay^2 \qquad (7)$$

Equation 4 becomes

$$z^3 + \left(\frac{6M}{b} - 3\lambda^2\right)z - \left(\frac{6I}{b} - 2\lambda^3\right) = 0 \qquad (8)$$

This equation may be written as

$$z^3 + Az - B = 0 \qquad (9)$$

where

$$A = \frac{6M}{b} - 3\lambda^2 \qquad (10)$$

and

$$B = \frac{6I}{b} - 2\lambda^3 \qquad (11)$$

A commonly occurring case is that of a 12-in. slice of a slab. In this case $b = 12$, and we have

$$A = \frac{M}{2} - 3\lambda^2 \qquad (12)$$

$$B = \frac{I}{2} - 2\lambda^3 \qquad (13)$$

By shifting from the variable x to the variable z, several advantages have been gained. From a mathematical viewpoint we have taken the first step required in the direct solution of any cubic equation, this step being the elimination of the second degree term. Formulas have been derived for the exact solution of Eq. 9 (I. S.

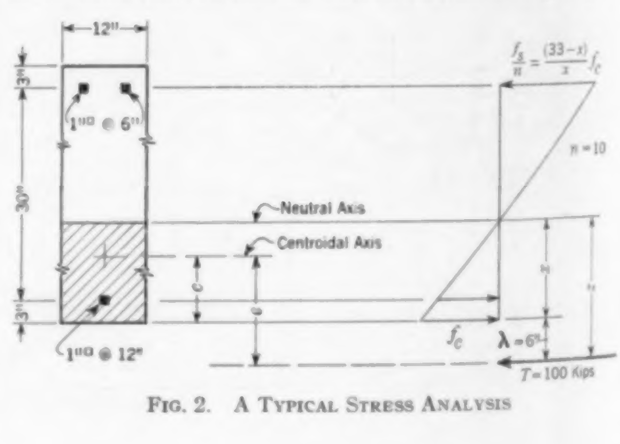


FIG. 2. A TYPICAL STRESS ANALYSIS

and I. S. Sokolnikoff, *Higher Mathematics for Engineers and Physicists*, McGraw-Hill, 1934, p. 19). The convenience of Eq. 9 to the engineer lies in the simple physical significance of M and I, which enter into the formulas for A and B. The quantities M and I are, respectively, the moment, and the moment of inertia, of the transformed steel areas about the line of thrust.

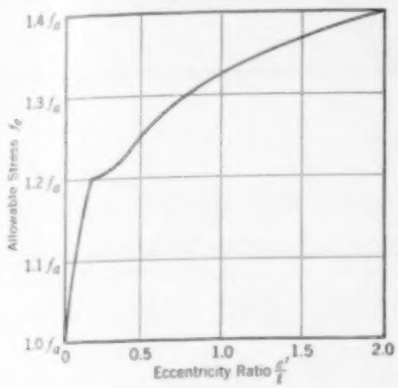


FIG. 3. ALLOWABLE CONCRETE STRESS FOR SECTION OF FIG. 2

Several methods of solving Eq. 9 are available. Although direct formulas exist, their use will usually require more time than a trial and error procedure. Graphical methods can be used with satisfaction for many cases. The method of A. W. Fischer (CIVIL ENGINEERING, April 1935, p. 260), in which $y = x^3$ is plotted, can be used. Or a nomograph may be used as illustrated by W. F. Wiley ("Developing Data for the Design Office," *Engineering News-Record*, August 28, 1941, p. 308). The writer has found a very convenient method, which applies in all cases, to be one of converging approximations. This is merely an improvement over the engineer's usual method of trial and error through the application of Newton's straight-line law of converging approximations (see Sokolnikoff, *op. cit.*, p. 32, and *Mathematical Methods in Engineering*, by T. von Kármán and M. A. Biot, McGraw-Hill, 1940, p. 192). If z_1 is our first trial value, then we obtain from Newton's law a correction ϵ to be deducted from z_1 to obtain a new value, z_2, which is closer to the true value of z. Thus we have

$$z_2 = z_1 - \epsilon \qquad (14)$$

where

$$\epsilon = \frac{\phi(z_1)}{\phi'(z_1)} \qquad (15)$$

$$\phi(z_1) = z_1^3 + Az_1 - B \qquad (16)$$

and

$$\phi'(z_1) = 3z_1^2 + A \qquad (17)$$

The use of Newton's law will cut in half the time required for a trial-and-error procedure. R. A. Whiteman has described the construction and operation of a special slide rule for solving cubic equations (CIVIL ENGINEERING, October 1934, p. 543). The method of iteration (von Kármán and Biot, *op. cit.*, p. 193) may be applied by writing Eq. 9 in either of the following forms:

$$z = \sqrt[3]{B - Az} \qquad (18)$$

or

$$z = \sqrt[3]{A}\sqrt[3]{\frac{B}{A} - z} \qquad (19)$$

These forms are particularly useful to a designer who possesses a slide rule with a cubic scale, since an assumed value can be checked by one setting of the slider. The designer should find out by practice which method of solution of this cubic equation he prefers, and use the method until it becomes another convenient tool at his command.

After the neutral axis is located, the properties of the transformed section may be computed. From these properties the allowable fiber stress may be determined from the formula given by the Joint Committee Specifications, which is,

$$f_c = f_a\left[\frac{1 + ec/R^2}{1 + C(ec/R^2)}\right] \qquad (20)$$

Since we have already computed the moment M and the moment of inertia I of the transformed steel areas about the line of thrust, it should be apparent that the line of thrust will be the most useful reference axis for computing the properties of the entire transformed section.

An application of the foregoing procedure to a specific case is shown in Fig. 2 and Table I. The computations are tabulated in the form suggested by Professor Hardy

TABLE I. COMPUTATIONS FOR CASE SHOWN IN FIG. 2

LINE NO.	a	y	ay	ay^2	i	I
(1)	20	39	780	30,400		
(2)	9	9	81	700		
(3)			861	31,100		31,100
(4)	173	13.2	2,280	30,100	3,000	33,100
(5)	202		3,141			64,200
	$e = 15.5$					48,700
	$c = 9.5$					15,500

$R^2 = 76.9$ $\quad \frac{ec}{R^2} = 1.91$ $\quad \frac{2}{3}\frac{ec}{R^2} = 1.27$

$z^3 + Az - B = 0$ $\quad A = 322$ $\quad B = 15,120$

$z = 20.4$ $\quad x = 14.4$

$f_c = 1.28 f_a$ $\quad f_c = 1,480$ $\quad f_s = 19,100$

Cross (*The Column Analogy*, Bulletin No. 215, Engineering Experiment Station, University of Illinois, 1930, p. 17) for dealing with combined stress problems. The first line of the table gives the transformed area of the tension steel with its moment and moment of inertia about the line of thrust; line (2) is for the compression steel. The third line is a summation, so that

$$M = \Sigma ay = 861 \qquad (21)$$

$$I = \Sigma ay^2 = 31,100 \qquad (22)$$

From these values we may compute A and B from Eqs. 12 and 13.

$$A = \frac{861}{2} - 3(6)^2 = 322 \qquad (23)$$

$$B = \frac{31,100}{2} - 2(6)^3 = 15,120 \qquad (24)$$

The value of z is then obtained by solving the equation,

$$z^3 + 322\,z - 15,120 = 0 \qquad (25)$$

This gives $z = 20.4$ in., and from Eq. 3 the value of x is found to be 14.4 in.

With the value of x determined, we may proceed to fill out the remainder of the table. Line (4) gives the area of the concrete which is in compression, with its moment and moment of inertia about the line of thrust. The value of the column with the caption "i" is the moment of inertia of this compressive area about its own centroid. A similar item for steel areas would be negligible and is not shown. Line (5) is a summation for the total transformed area. Dividing this moment by the area gives the distance e from the line of thrust to the centroid, which in turn gives the quantity 48,700 to be deducted from I about the line of thrust to obtain 15,500, the I about the centroid. The next step is to compute c from Fig. 2 and R^2 from the known values of the area and moment of inertia of the transformed section. The allowable stress may now be computed from the Joint Committee formula, Eq. 20. The value

$C = {}^2/_3$ has been used. The existing maximum concrete stress is obtained by substituting in Eq. 1 and is found to be 1,480 lb per sq in. From the geometry of the stress diagram the tensile steel stress is found to be 19,100 lb per sq in.

It is interesting to note that, if the eccentricity of the thrust is specified, all the properties of the transformed section can be computed without knowledge of the magnitude of the thrust. Therefore it is possible to compute and plot a curve, for a particular section, showing the relation between the allowable fiber stress and the eccentricity of the thrust as given by the Joint Committee formula. Such a curve, based on Eq. 20, and for $C = {}^2/_3$, is shown in Fig. 3 for the section of Fig. 2.

Our Readers Say—

In Comment on Papers, Society Affairs, and Related Professional Interests

The Engineering Profession and the Economic Situation

To the Editor: I read Bernard L. Weiner's article, "Engineers and World Economy," in the December issue, and am forced to disagree almost entirely with Mr. Weiner's conclusions. As pointed out in the subsequent discussion of his article, it seems to me that he errs in at least three major assumptions: (1) that men trained in the physical sciences can carry over their methodology to the social sciences; (2) that economic research has either been non-existent, or at best superficial; and (3) that the recent depression is clear evidence of the inefficiency and ineptitude of the economist.

In his article Mr. Weiner decries the economist's supposed preoccupation with monetary problems and indirectly blames such engrossment for the unsolved business cycle. Whereas, economists who have spent years studying the business cycle are not quite fully agreed as to the causes of depressions, they are in substantial agreement that the problem will not be solved by monetary means alone. For instance, one of the major causes of the cycle is technological unemployment, which is a function of the rate at which new technological methods are introduced. No price-level stabilization, by means of unhoardable dollars (as has at times been suggested), can control that. Many other business cycle causes, which are not subject to monetary control, could be mentioned.

Such proposed panaceas are typical of the mechanistic solutions for economic problems, suggested by men trained in naught but physical theory. When engineers appreciate that the "materials" of the social sciences are men and women, who act, change, and react to economic stimuli, and by anticipating the effects of such stimuli, tend to neutralize them, perhaps they will realize that they are "experts" only in their own field.

It has been strongly intimated that economics is not a science, but rather a mumbo-jumbo of ignorance, whose very high priests do not understand the phraseology. The methodology of economics is as "scientific" as any developed in the physical sciences. However, the quantities are not only of a different order, but also of an entirely different character. Hence they are measured with different tools, and subject to schemata of analysis quite unlike those in physics and chemistry. The writer has heard it said that if Adam Smith, Karl Marx, Alfred Marshal, and John Maynard Keynes could get together, they would not disagree as to the probable result of a given economic act in a given economic order, but that they would disagree violently as to the ulterior factors responsible for that result. Economics is an exact science, with an infinity of ramifications. The major difficulty is in knowing the component atoms of the system—human beings. It is they that cause the difficulty. The aggregates these beings form—markets, consumers, production units, and so on—are entirely subject to exact analysis.

The solution of world economic problems will be enhanced greatly when the untrained cease dabbling in economics, and when acknowledged preeminence in one field of knowledge will not be presumed to give one omniscience.

David A. Kosh, Jun. Am. Soc. C.E.
Research Assistant, Public Utilities Department, New York University

New York, N.Y.

Comments on Cable-Sag Calculations

To the Editor: The article on "Simplified Cable-Sag Calculations" by C. M. Goodrich, in the February issue of Civil Engineering, is interesting, but the "trial" method presented offers little, if any, economy in time and is not as accurate as that derived by the equating of the basic equations of this problem.

From Mr. Goodrich's article, the following formulas may be restated

$$S = \frac{wL^2}{8T} \qquad (1)$$

$$L_1 = L + \Delta L \qquad (2)$$

For a change in loading only, the length L_s of the cable becomes

$$L_s = L_0 - \frac{L_0(T_0 - T)}{AE} \qquad (3)$$

for a change in both loading w and temperature t,

$$L_s = L_0 - \frac{L_0(T_0 - T)}{AE} + \epsilon t L_0 \qquad (4)$$

also,

$$L_1 = L + \frac{8S^2}{3L} \qquad (2)$$

Whence

$$S^2 = \frac{3}{8} L\,(L_1 - L) \text{ and } S_0^2 = \frac{3}{8} L\,(L_0 - L) \qquad (5)$$

By combining and substituting in Eqs. 1 to 5, there results the following, for the determination of the sag S.

Case 1—Sag of cable for a change in temperature t only,

$$S^3 - S\left[S_0^2 + \frac{3L_0L}{8}\left(\epsilon t - \frac{T_0}{AE}\right)\right] - \frac{3L_0LT_0S_0}{8AE} = 0 \qquad (6)$$

Case 2—Sag of cable for a change in loading w only,

$$S^3 - S\left[S_0^2 - \frac{3L_0LT_0}{8AE}\right] - \frac{3L_0LT_0wS_0}{8AEw_0} = 0 \qquad (7)$$

Case 3—Sag of cable for a change in both temperature t and loading w,

$$S^3 - S\left[S_0^2 + \frac{3L_0L}{8}\left(\epsilon t - \frac{T_0}{AE}\right)\right] - \frac{3L_0LT_0wS_0}{8AEw_0} = 0 \qquad (8)$$

In these formulas W_0, T_0, S_0, and L_0 are values for the initial loading on the cable. For the examples given by Mr. Goodrich, the results given by the above formulas are as follows:

For a rise in temperature t to 120 F, with the ice off the cable and no wind load, from Eq. 8 the sag S of the cable is 31.93 ft as compared to Mr. Goodrich's result of 32 ft.

For a rise in temperature t to 30 F, the ice load being unchanged but with no wind load, from Eq. 8 the sag S of the cable is 28.73 ft instead of 31.4 ft and the horizontal tension T in the cable is then 3,487 lb instead of 3,190 lb.

Williamsport, Pa. C. D. Meals, Assoc. M. Am. Soc. C.E.

Spring Meeting in Roanoke, Va.

Hotel Roanoke to Be Headquarters, April 21–22–23, 1942

Opening Session and General Meetings

WEDNESDAY—April 22, 1942—Morning

Grand Ballroom, Hotel Roanoke

9:00 **Registration**

Palm Court, Hotel Roanoke

10:00 **Spring Meeting called to order by**

EUGENE S. THOMAS, *President, Virginia Section, Am. Soc. C.E.*, Roanoke, Va.

10:05 **"America" by all assembled, led by**

JAMES BREAKELL, *Chief Engineer, American Viscose Corporation*, Roanoke, Va.

10:10 **Invocation**

ZEBULON VANCE ROBERSON, *Minister, Raleigh Court Presbyterian Church*, Roanoke, Va.

Addresses of Welcome

10:15 THE HON. WALTER W. WOOD, *Mayor of the City of Roanoke.*

10:25 NORMAN W. KELLEY, *President, Roanoke Chamber of Commerce.*

10:35 **Response by**

MAJ. E. B. BLACK, *President, American Society of Civil Engineers.*

The papers which follow are sponsored by the Highway Division, of which COL. C. E. MYERS, *M. Am. Soc. C.E., is chairman, and* CAPT. C. D. CURTISS, *M. Am. Soc. C.E., is secretary.*

11:00 **Highway Transport in War Time**

H. S. FAIRBANK, *Chief, Division of Research, Planning and Information, Public Roads Administration*, Washington, D.C.

11:20 **Discussion by**

BRIG. GEN. JAMES A. ANDERSON, *M. Am. Soc. C.E., Commissioner, State Highway Department*, Richmond, Va.

11:30 **War-Time Highway Problems**

ROY W. CRUM, *M. Am. Soc. C.E., Director, Highway Research Board, National Research Council*, Washington, D.C.

11:50 **General discussion**

12:00 **Adjournment**

Wednesday Luncheon

12:15 p.m., Main Dining Room
Hotel Roanoke

At the close of the Wednesday morning session, there will be a luncheon in the Main Dining Room.

CAPT. L. B. COMBS, *CEC, U.S.N., M. Am. Soc. C.E., Assistant Chief, Bureau of Yards and Docks, Navy Department*, Washington, D.C., will address the luncheon on

"THE CIVIL ENGINEERS OF THE NAVY"

Tickets for the luncheon are $1.10 for members; 60 cents for members of Student Chapters.

Symposium on Civilian Protection in War Time

WEDNESDAY—April 22, 1942—Afternoon

Grand Ballroom, Hotel Roanoke, 2:00 p.m.

CHARLES H. STEVENS, *Vice-President, Am. Soc. C.E., Chairman of the Meeting*

ERNEST P. GOODRICH, *Director, Am. Soc. C.E., National Chairman of the Society's National Committee on Civilian Protection in War Time, Presiding*

This symposium has been prepared and is presented by the Society's National Committee on Civilian Protection in War Time. We are less sure that American cities are safe from aerial bombardment than we were six months ago. We are more sure that American plants are not safe against sabotage by the enemy. This program is presented as a part of the Society's contribution to give technical aid in protecting the lives and property of civilians.

This is a closed session. Attendance is open to members who will pledge not to divulge the information presented to the detriment of the United States. The nature of the program precludes the attendance of reporters, non-citizens, and non-members unless vouched for by the Secretary.

PREPARE BEFORE INSTEAD OF REPAIR AFTERWARDS

2:00 **Introductory remarks**

ERNEST P. GOODRICH, *M. Am. Soc. C.E., Consulting Engineer*, New York, N.Y.

2:05 **Protection of Electric Power Facilities**

THOMAS R. TATE, *Director, National Defense Power Staff, Federal Power Commission*, Washington, D.C.

2:30 **Vulnerability of Power Plants to Sabotage, and Their Protection**

ROBERT H. CUNNINGHAM, *Special Agent, Federal Bureau of Investigation, United States Department of Justice*, Washington, D. C.

2:55 **General discussion**

3:15 **Selection of Evacuation Routes**

RAY F. RIEGELMEIER, *Traffic Engineer, Commonwealth of Pennsylvania, Department of Highways*, Harrisburg, Pa.

3:40 **Discussion**

3:50 **Before Your City Is Bombed—A Colloquy**

ALLEN J. SAVILLE, *M. Am. Soc. C.E., Consulting Engineer, Slaughter, Saville and Blackburn*, Richmond, Va.

Interlocutor: ERNEST P. GOODRICH, *M. Am. Soc. C.E., Consulting Engineer*, New York, N.Y.

4:35 **Open discussion**

5:00 **Adjournment**

WEDNESDAY—April 22, 1942—Morning

9:00 **Registration, Palm Court, Hotel Roanoke**

10:00 **Attend Society's Opening Session, Grand Ballroom, Hotel Roanoke**

12:15 **Students will join members at the luncheon in the Main Dining Room, Hotel Roanoke**

CAPT. L. B. COMBS, *CEC, U.S.N., M. Am. Soc. C.E., Assistant Chief, Bureau of Yards and Docks, Navy Department*, Washington, D.C., will address the luncheon on

"THE CIVIL ENGINEERS OF THE NAVY"

Special tickets for members of Student Chapters are 60 cents each.

WEDNESDAY—April 22, 1942—Afternoon

Parlors A-B-C, Hotel Roanoke

This program was arranged by the Society's Committee on Student Chapters, E. M. HASTINGS, *Chairman;* and by the Virginia Military Institute Student Chapter, COL. R. A. MARR, JR., *Faculty Adviser*

CADET J. A. HUGHES, *President, Virginia Military Institute Student Chapter, Presiding*

2:00 **Assembly and Registration**

2:30 **Call to order**

CADET J. A. HUGHES, *President, Virginia Military Institute Student Chapter.*

2:45 **Introduction of Franklin P. Turner**

W. F. CLINE, *President, Virginia Polytechnic Institute Student Chapter.*

Address of Welcome on Behalf of the Virginia Section and the City of Roanoke

FRANKLIN P. TURNER, *M. Am. Soc. C.E., Contact Member, Virginia Polytechnic Institute Student Chapter, Principal Assistant Engineer, Norfolk and Western Railway*, Roanoke, Va.

3:00 **The Future for Young Engineers**

MAJ. E. B. BLACK, *President, Am. Soc. C.E., Consulting Engineer, Black and Veatch*, Kansas City, Mo.

3:15 **Roll Call of States and Student Chapters**

Three-minute address from one representative of each Student Chapter.

4:00 **Pessimist or Optimist**

E. M. HASTINGS, *M. Am. Soc. C.E., Chairman, Society's Committee on Student Chapters, Chief Engineer, Richmond, Fredericksburg and Potomac R.R.*, Richmond, Va.

4:45 **Announcement of evening program plans**

E. BOYD LIVESAY, *President, University of Virginia Student Chapter.*

5:00 **Adjournment**

Formal Dinner and Address

WEDNESDAY—April 22, 1942—Evening

7:00 p.m., Grand Ballroom, Hotel Roanoke

DR. WILLIAM O. HOTCHKISS, *M. Am. Soc. C.E., Deputy Director General, Army Specialist Corps*, Washington, D.C., *former President, Rensselaer Polytechnic Institute*, Troy, N.Y., will address members and guests on

"THE ARMY SPECIALIST CORPS"

During dinner, the "V.M.I. Commanders," the Student Corps orchestra, will furnish music, and following Dr. Hotchkiss' address, will continue for dancing.

Tickets are $3.50 for men; $2.50 for ladies; and $1.25 each for members of Student Chapters and their dates.

WEDNESDAY—April 22, 1942—Evening

Grand Ballroom, Hotel Roanoke

7:00 **Members of Student Chapters and their dates will join members and guests in the Grand Ballroom for dinner to be followed by dancing**

The dinner will be addressed by DR. WILLIAM O. HOTCHKISS, *M. Am. Soc. C.E., Deputy Director General, Army Specialist Corps*, Washington, D.C., *former President, Rensselaer Polytechnic Institute*, Troy, N.Y., on the subject of

"The Army Specialist Corps"

Special tickets for members of Student Chapters and their dates are $1.25 each.

THE UNIVERSITY OF VIRGINIA

This Campus Is Considered One of the Most Beautiful in America

WASHINGTON AND LEE UNIVERSITY

Another Beautiful Campus, to Be Visited on Thursday Afternoon

Sessions of Technical Divisions

THURSDAY—April 23, 1942—Morning

SOIL MECHANICS AND FOUNDATIONS DIVISION

Parlor A, Hotel Roanoke

CARLTON S. PROCTOR, *Chairman, Executive Committee, Presiding*

9:30 **Introductory remarks by**

CARLTON S. PROCTOR, *M. Am. Soc. C.E., Consulting Engineer, Moran, Proctor, Freeman and Mueser*, New York, N.Y.

9:40 **The Design of Concrete Pavements for Highways and Airports**

WILLIAM E. BARKER, *Regional Highway Engineer, Portland Cement Association*, Atlanta, Ga.

10:20 **Discussion**

10:50 **The Use of Field Bearing Tests in Airport Runway Design**

GEORGE E. BERTRAM, *Office, Chief of Engineers*, Washington, D.C.

11:30 **Discussion by**

PRÉVOST HUBBARD, *Affiliate, Am. Soc. C.E., Chemical Engineer, The Asphalt Institute*, New York, N.Y.

11:40 **General discussion**

12:00 **Adjournment**

STRUCTURAL DIVISION

Parlor B, Hotel Roanoke

A SYMPOSIUM ON SAVING AND CONSERVING STRUCTURAL STEEL

J. M. GARRELTS, *Secretary, Executive Committee, Presiding*

So much steel must be used for guns, tanks, and ammunition that engineers are now charged more than ever with conservation of this important material by substituting alternate materials such as wood and concrete and by improving design and increasing working stresses.

9:30 **Introductory remarks**

J. M. GARRELTS, *Assoc. M. Am. Soc. C.E., Associate Professor, Civil Engineering, Columbia University*, New York, N.Y.

9:40 **Conserving Steel in Designing Steel Structures**

SHORTRIDGE HARDESTY, *M. Am. Soc. C.E., Consulting Engineer, Waddell and Hardesty*, New York, N.Y.

10:10 **Discussion by**

F. H. FRANKLAND, *M. Am. Soc. C.E., Director of Engineering, American Institute of Steel Construction, Inc.*, New York, N.Y.

10:20 **Saving Structural Steel by Using Reinforced Concrete**

HARDY CROSS, *M. Am. Soc. C.E., Professor, Civil Engineering, Yale University*, New Haven, Conn.

10:50 **Discussion**

11:00 **Saving Steel, Time, and Men in Construction by the Use of Timber**

JOHN J. GOULD, *Assoc. M. Am. Soc. C.E., Consulting Structural Engineer*, San Francisco, Calif.

Discussion by

11:30 WILLIAM G. ATWOOD, *M. Am. Soc. C.E., Consulting Engineer*, Winter Park, Fla.

11:40 J. F. SEILER, *Principal Engineer, American Wood Preservers' Association*, Washington, D.C.

11:50 **General discussion**

12:00 **Adjournment**

Thursday Luncheon

12:15 p.m., Grand Ballroom, Hotel Roanoke

At the close of the Thursday morning sessions, there will be a luncheon in the Grand Ballroom.

MAJ. GEN. EUGENE REYBOLD, *U.S.A., M. Am. Soc. C.E., Chief of Engineers, War Department*, Washington, D.C., will address the luncheon on

"THIS IS AN ENGINEER'S WAR"

Tickets for the luncheon are $1.10 for members; 60 cents for members of Student Chapters.

Sessions of Technical Divisions

THURSDAY—April 23, 1942—Afternoon

SANITARY ENGINEERING DIVISION

Parlor B, Hotel Roanoke

LINN H. ENSLOW, *Chairman, Executive Committee, Presiding*

2:00 **Sanitary and Public Health Engineering Phases of the Civilian Protection Program**

SAMUEL A. GREELEY, *M. Am. Soc. C.E., Greeley and Hansen*, Chicago, Ill., *Division Chairman, Sanitary and Public Health Engineering Division of the National Committee of the American Society of Civil Engineers on Civilian Protection in War Time.*

The Sanitary and Public Health Engineering Division of the Society's National Committee on Civilian Protection in War Time reported in the January 1942 PROCEEDINGS, on protective and remedial measures for these services on behalf of our civil population should active warfare come to our shores. Local Section committeemen have studied this report and have reported numerous local steps and plans. Mr. Greeley will present a résumé of specific Local Section activities and conduct a round-table discussion of them.

2:40 **Round-table discussion**

3:00 **Work of the Water and Sewerage Group, Metropolitan Area of Civilian Defense, Washington, D.C.**

M. O. LEIGHTON, *M. Am. Soc. C.E., Consulting Engineer, Leighton and Gamble*, Washington, D.C.

3:30 **Discussion**

3:40 **The Water Supply and Sewerage Defense Program for North Carolina**

H. G. BAITY, *M. Am. Soc. C.E., Professor, Sanitary Engineering, University of North Carolina*, Chapel Hill, N.C.; *Chairman, Subcommittee on Sanitary and Public Health Engineering, North Carolina Section's Committee on Civilian Protection in War Time.*

4:10 **Discussion**

4:20 **Solving the Defense Water Supply Problems in the Hampton Roads Area of Virginia**

REEVES J. NEWSOM, *M. Am. Soc. C.E., Newsom and Aldrich*, New York, N.Y.

4:50 **Discussion**

5:00 **Adjournment**

CONSTRUCTION DIVISION

Parlor A, Hotel Roanoke

HARRY O. LOCHER, *Chairman, Executive Committee, Presiding*

2:00 **Introductory remarks**
HARRY O. LOCHER, *M. Am. Soc. C.E., Secretary-Treasurer, The National Association of River and Harbor Contractors*, New York, N.Y.

2:10 **Construction of Powder Plants in Virginia**
HOWARD L. KING, *M. Am. Soc. C.E., Chief Engineer, Mason and Hanger Co., Inc.*, New York, N.Y.

2:50 **Discussion**

3:20 **Heavy Construction Equipment in Use on War Work**
KENNETH F. PARK, *Assoc. M. Am. Soc. C.E., Chief Field Engineer, R. G. LeTourneau, Inc.*, Peoria, Ill.
Discussion by

4:00 JAMES I. BALLARD, *M. Am. Soc. C.E., Assistant to the Publisher, "Engineering News-Record,"* New York, N. Y.

4:15 ELLIS G. MIDDLETON, *M. Am. Soc. C.E., Senior Highway Engineer, Public Roads Administration*, Roanoke, Va.

4:30 **General discussion**

4:45 **Adjournment**

SURVEYING AND MAPPING DIVISION

Parlor C, Hotel Roanoke

WILLIAM N. BROWN, *Chairman, Executive Committee, Presiding*

2:00 **Topographic Mapping for Defense**
HERBERT B. LOPER, *Lieutenant-Colonel, Corps of Engineers, U.S. Army*, Washington, D.C.

2:45 **Discussion**

3:00 **The Contribution of Control Surveys to the War Effort**
CLEMENT L. GARNER, *M. Am. Soc. C.E., Captain and Chief, Division of Geodesy, U.S. Coast and Geodetic Survey*, Washington, D.C.

3:45 **Discussion**

4:00 **General discussion**

5:00 **Adjournment**

Ladies' Motor Trip, and Picnic Supper For All

THURSDAY—April 23, 1942—Afternoon

Motor Trip, Tea, Military Review, Picnic Supper

1:30 **Leave Hotel Roanoke by Greyhound Bus**

3:00 **Arrive Campus Washington and Lee University, Lexington, Va.**
Visit Lee Chapel and University Buildings and Grounds.

3:30 **Escorted Tour of Virginia Military Institute Grounds Adjoining Those of Washington and Lee University**

4:00 **Tea at Preston Library, Virginia Military Institute**
Served by the ladies of the civil engineering faculty of Virginia Military Institute.

4:30 **First Call Formal Cadet Review**
Before President Black, members of the Board of Direction, and distinguished guests.

4:40 **Assembly**

5:15 **Leave by bus for Natural Bridge**

6:00 **Arrive at Natural Bridge**
The ladies will be joined by the men who will arrive from Roanoke for a picnic supper.

Tickets for ladies' trip to Lexington including round trip bus ticket, admission to Lee Chapel, admission to Natural Bridge, and picnic supper, are $3.30 each.

THURSDAY—April 23, 1942—Evening

PICNIC SUPPER

At the close of the Technical Divisions' sessions on Thursday, transportation will be provided in private cars to take the men from Hotel Roanoke to Natural Bridge where they will join the ladies, who will arrive from Lexington at 6 p.m. Picnic supper will be served under the Bridge.

Tickets for men, including entrance to Natural Bridge and picnic supper, are $1.80 each.

VIRGINIA MILITARY INSTITUTE AS SEEN FROM THE AIR

Local Sections Conference

TUESDAY—April 21, 1942—All Day

Parlors C-D, Hotel Roanoke

WILLIAM M. SPANN, *Chairman, Society's Committee on Local Sections, Presiding*

The first Regional Local Sections Conference for 1942 will include 17 Local Sections of the southern and eastern areas of the country. All interested members of the Society are invited to attend and are urged to participate in the discussions. The official representatives will discuss generally the following main subjects, and in detail, the specific titles listed below:

CIVILIAN PROTECTION ACTIVITIES OF LOCAL SECTIONS

UNIONIZATION AND THE ENGINEERING PROFESSION

STIMULATING LOCAL SECTION ACTIVITIES DURING WAR TIME

Morning, 9:30–12:00 a.m.

9:30 **Address of Welcome**

EUGENE S. THOMAS, *President, Virginia Section, Am. Soc. C.E.*, Roanoke, Va.

9:45 **Introduction of Local Section representatives**

WILLIAM M. SPANN, *Chairman, Society's Committee on Local Sections.*

9:50 **CIVILIAN PROTECTION ACTIVITIES OF LOCAL SECTIONS**

ERNEST P. GOODRICH, *National Chairman, Society's National Committee on Civilian Protection in War Time*, will present a brief outline of the type of work in which Local Sections are expected to participate, and the results obtained by some of them.

10:15 **Response by each Local Section representative**

12:00 **Adjournment**

Virginia Section Calls Spring Meeting

TUESDAY—April 21, 1942—Evening

Grand Ballroom, Hotel Roanoke

The Virginia Section has called a meeting for Tuesday evening at 6 p.m. Following a social hour at 6 p.m., and a dinner at 7 p.m., a short business meeting will be held. All members and their ladies are invited.

12:15 **Luncheon**

Local Section representatives will join members of the Board of Direction, and members of the Technical Procedure Committee, at the luncheon in Parlors A-B, Hotel Roanoke.

MAJOR E. B. BLACK, *President, American Society of Civil Engineers*, will address the luncheon on

"THE IMPORTANCE OF THE SOCIETY IN THE WAR EFFORT"

Tickets are $1.10 each.

Afternoon, 2:00–5:00 p.m.

2:00 **UNIONIZATION AND THE ENGINEERING PROFESSION**

GEORGE T. SEABURY, *Secretary, American Society of Civil Engineers.*

2:40 **Response by each Local Section representative**

3:45 **STIMULATING LOCAL SECTION ACTIVITIES IN WAR TIME**

(*a*) Section Meetings and Maintenance of Member Interest During the War Period

(*b*) Local Section Records

(*c*) Use of CIVIL ENGINEERING as a Forum for Discussion of Society's Professional Activities

(*d*) Selection of Personnel for Section and Society Committees

5:00 **Adjournment**

GAS FIRE CAUSED BY BOMB EXPLODING UNDER THE PAVEMENT

See Article by Sherwood Smith, "Protection Aspects of Civilian Defense," to Appear in May CIVIL ENGINEERING

Hotel Accommodations and Announcements

Hotel Rates

Hotels	All with Private Bath: Single	Twin Bed
*Hotel Roanoke, Roanoke, Va.:		
Non air-conditioned	$3.00 up	$5.00 up
Air-conditioned	$3.50 up	$6.00 up
†Hotel Patrick Henry, Roanoke, Va.	$2.50 up	$5.00 up
‡Hotel Ponce de Leon, Roanoke, Va.	$2.00 up	$4.00 up

* Three persons to a room, $2.50 per person.
† Three or four persons to a room, $2.00 per person; five or six persons to a room, $1.75 per person; and seven or eight persons to a room, $1.50 per person
‡ Three to five persons to a room, $1.50 per person.

The Hotel Roanoke is the Society's Headquarters for the Spring Meeting.

Advance Reservations

To be certain of hotel accommodations, members are urged to make reservations in advance of the meeting date, with Mr. Kenneth R. Hyde, who in addition to being manager of the Hotel Roanoke, is also manager of the Roanoke Hotel Convention Bureau. No other conventions are scheduled for Roanoke at the time of our Spring Meeting. Mr. Hyde will make reservations for members at the hotel of their choice.

It is only by having, in advance, a close estimate of the number of guests to be provided for, that those in charge of the program and the hotel management can have everything in readiness.

Everyone attending the Spring Meeting is requested to register at Society Headquarters, Hotel Roanoke, immediately upon arrival.

Tickets and badges will be obtained at time of registration.

Information

An Information Desk will be provided in the Palm Court, Hotel Roanoke, to assist visiting members and to furnish information about the meeting and the city.

Every effort will be made to deliver messages and telegrams promptly. Mail for members received at Society Headquarters will be held at the Information Desk. Undelivered letters at the close of the meeting will be forwarded to latest mailing address.

The hotel will make bus, air, railroad, and pullman reservations.

Train travel to Roanoke is convenient, but in view of existing conditions in rail transportation, it is urged that members contemplating using rail service, make their rail and pullman reservations to and from Roanoke just as early as possible.

Golf and Tennis

Arrangements can be made with the Reception Committees or the hotel management for members and ladies to play golf or tennis at the Roanoke Country Club.

Entertainment for the Ladies

Attention is directed to the motor trip to Lexington, provided for the ladies. However, they may participate with members in the other features of the program except the closed session on Wednesday afternoon.

Local Sections Conference, Tuesday, April 21, 1942

A conference of representatives of Local Sections will meet at 9:30 a.m., Tuesday, April 21, 1942, at Hotel Roanoke. The program will schedule topics of professional rather than technical interest in which all representatives are expected to participate. All members of the Society present on Tuesday are welcome to attend. For further details, see program.

Student Chapter Conference, Wednesday, April 22, 1942

Members of Student Chapters are invited to participate in all events of the Spring Meeting. Special attention is called to the program of the Student Chapter Conference on Wednesday afternoon. For complete details, see program.

Dress

Because of the war, it has been decided that only at the dance will dinner jackets be in order. All other functions will be informal.

Officers of Virginia Section

EUGENE S. THOMAS, *President*
WILLIAM R. GLIDDEN, *Vice-President*
RICHARD MESSER, *Vice-President*
THOMAS W. ROBY, *Vice-President*
P. A. RICE, *Secretary-Treasurer*

Ladies' Reception Committee

MRS. EUGENE S. THOMAS, *Chairman*

MRS. CHAPMAN J. FRENCH
MRS. FREDERICK C. JAMES
MRS. CHESTER W. OGDEN
MRS. NORTON STONE
MRS. FRANKLIN P. TURNER
MRS. CHARLES R. WENTWORTH
MRS. JOHN L. WENTWORTH
MRS. WILLIAM P. WILTSEE

Men's Reception Committee

WILLIAM P. WILTSEE, *Chairman*

JOSEPH E. CRAWFORD
CHESTER W. OGDEN
EUGENE S. THOMAS
FRANKLIN P. TURNER

The program as a whole has been prepared under the direction of the Spring Meeting Committee composed of CHARLES H. STEVENS, *Vice-President, Am. Soc. C.E., Chairman;* and CLIFFORD G. DUNNELLS, SCOTT B. LILLY, ARMOUR C. POLK, and GUSTAV J. REQUARDT, *Directors, Am. Soc. C.E.*

HOTEL ROANOKE, OFFICIAL HEADQUARTERS OF THE SPRING MEETING

The speakers on this program who have consented to be present at this meeting are making a direct tangible contribution to aid our members in helping the Government to win the war. Nevertheless, the speakers have accepted invitations to speak contingent upon emergencies that may develop.

SOCIETY AFFAIRS

Official and Semi-Official

Amendment to Constitution Affects Juniors

Special Society Meeting, March 18

As previously announced, a special Society meeting was held on Wednesday, March 18, to receive the vote of the tellers on a revision to the Constitution raising the age limit and dues of Juniors, as passed to ballot at the Annual Meeting in January. The special meeting was called at 4 p.m. with Director E. P. Goodrich in the chair. Call for the meeting was read. It was announced that the only business before the meeting was to receive the report of the tellers.

Details of the proposed amendment were given in the December issue. They were also sent individually to Corporate Members under date of December 5, together with a statement from the Committee on Membership Qualifications. The proposals were two in number: to extend the limiting age of Juniors to 35 years (it is now 33 years); and to provide a sliding-scale advance of $2.50 per year in their dues, commencing at age 32 and continuing until Junior membership ceases at age 35.

The proposed amendment was overwhelmingly approved by a vote of approximately ten to one, although the Constitution requires an affirmative vote of but two-thirds of all ballots cast for the adoption of any amendment. The official report of the tellers is appended. The chairman announced the official adoption of the amendment. There being no further business, the meeting adjourned.

Details are now being worked out as to the procedures and schedules for putting these changes into effect. The changes go into effect thirty days after the canvass, that is, on April 17, 1942. Two classes of Juniors immediately become affected, those who have already reached age 32 and those who in the coming months will reach this age. As soon as a general policy has been determined, official announcement will be made, probably in the May issue. All the Juniors affected will be notified in advance.

Report of Tellers on Canvass of Ballots

March 18, 1942

To the Secretary
American Society of Civil Engineers

The tellers appointed to canvass the ballot on amendment to the Constitution report as follows:

Total number of ballots received...........			4,241
Ballots excluded from the canvass			
From members in arrears of dues..		17	
Without signature................		14	
With illegible signature...........		3	
Total ballots not canvassed.............			34
Total ballots canvassed....................			4,207
Yes..................	3,810		
No....................	385		
Blank.................	6		
Void.................	6		
Total......................		4,207	
Total votes counted (Yes or No)		4,195	
Required to carry.............		2,797	
Carried by...................		1,013	

Respectfully submitted,
Ralph H. Mann, *Chairman*

D. G. Baillie, Jr.
C. K. Conard
Ian B. Packman
Robert H. Fraser
D. B. Hall
E. DeV. Tompkins
James McB. Webster
S. J. Harwi
I. F. Ashworth
J. I. Ballard
Tellers

Question Forum on Engineering Economics

The Executive Committee of the Engineering Economics Division has selected from among the replies received, the following in answer to its question published in Civil Engineering for February: "*How may the social gains anticipated as a result of the construction of an engineering project be evaluated in engineering terms?*"

From David A. Kosh, Jun. Am. Soc. C.E.—"The preliminary analysis of a project involves an estimate of the quantity of goods or services that can be sold at various prices. For example, before the technical design of a bridge can start, the probable volume of traffic must be estimated. But this volume will in general vary with the toll charged. That is, we must establish the relation between the quantity sold and the price demanded. In its simplest form this 'demand function,' or the relation between price and demand, will take the form,

$$p = \eth(q)$$

where p = price and q = quantity demanded.

"At a given price p_0 there will be taken a quantity q_0. The project revenue will be p_0q_0. However the 'social revenue' will normally exceed p_0q_0, for there will be consumers who would have paid more than p_0 had they been 'forced' to do so. This 'social revenue' is then expressed by

$$\int_0^{q} \eth(q)dq$$

"If $C(q)$ represents the total cost function of the project, then the 'net social gain' is given by

$$\int_0^{q_0} \eth(q)dq - C(q_0)$$

"After the functions are specified, we may then solve for the value of q_0, which will maximize the 'net social gain.'

"The assumption that the demand and cost functions involve only the parameter is a usual, but not essential simplification of the problem. The addition of other variables refines and complicates the econometric technique of solution. The general conclusions concerning 'net social gain' remain as before.

"It may be enlightening to note that an evaluation of social gain is an economic problem, even if made in engineering terms."

From Nathan Cherniack, Assoc. M. Am. Soc. C.E.—"Social gains resulting from the construction (and operation) of an engineering project can only accrue from an expansion in the aggregate annual productivity of the community. By productivity is meant the aggregate output of the community in the form of products and services.

"If with the aid of the project, new or greater volumes of products or services are produced directly, these could be readily measured. If, however, the project makes possible only benefits, then the potential products or services that would be made possible thereby must first be estimated.

"Were the increased annual products or services (whether real or potential) resulting from the project, produced directly under existing methods, they would require (a) so many acres of land, (b) so many man-hours of labor, (c) certain quantities of material, and (d) certain amounts of money to cover capital and interest requirements. On the other hand, the construction and operation of the project itself would require definite amounts of land, labor, materials, and capital.

"By comparing the (presumably) larger amounts of these four factors required to produce directly under existing methods, the

increased volumes of products and services that would result indirectly from the project itself, with the (presumably) smaller amounts of the four factors required to construct and operate the project, the differences in the four factors would thus measure the social gains in the engineering terms of land, labor, materials, and capital.

"If the project not only supplements but also makes obsolete existing methods of production, then the reduction in productivity through such obsolescence must be considered as a further offset to the gross social gains resulting from the project unless such obsolescence liberates an equal amount of potentially productive land, labor, materials, and capital.

"Where the project is self-liquidating in character, the fact that annual revenues exceed annual fixed and operating charges, indicates that the users alone, in the aggregate, are deriving social gains in excess of even the net income of the project, since the users must feel that they are receiving, in return, products or services worth more than the equivalent man-hours of labor which their payments represent. Besides, non-users of the project may also derive indirect benefits by virtue of the project, which benefits must also be added to the aggregate social gains resulting from the project. Hence self-liquidating projects create social gains.

"Where the project is partially or entirely tax supported, it is usually only an assumption that it would produce products or services or benefits which would make for a volume of potential products or services that would exceed those that the same quantities of the four factors would produce if constructed and operated individually or privately. In other words, where the users of the project cannot indicate its value by some type of revenue payments, only a measure of the real or potential output of a given project (with the same effectiveness that cost input is usually measured and scrutinized) can reveal, definitely, that the project does represent a social gain."

The question for this month follows:

> *"Should the relationship between the net depreciation reserve set up on a public utility company's books and the value of the property used and useful in rendering service, affect the amount allowed to be earned for 'depreciation' in arriving at rates?" (Disregard court decisions.)*

Let it be remembered that answers should be addressed to

Engineering Economics Division
R. A. Willis, Secretary
1306 Syndicate Trust Building
St. Louis, Mo.

and should be in not later than March 25.

"Research—A National Resource"

MEMBERS of the Society may find a source of inspiration in a series of reports issued by one of the committees of the National Resources Planning Board on "Research—a National Resource." This title is a reminder of the steady consistent work of the Board, which has made constructive progress in taking an inventory of our national resources. That the Board should consider research as one of these resources is especially significant.

Not everyone can carry arms, not everyone can abandon his daily task or his family responsibilities to accept work that aims a direct blow at the enemy. But one thing every Society member can do is to make his individual contribution to the composite pattern of practical thinking that constitutes engineering research, and thus to supply from his own background the facts needed to solve emergency defense problems. This is the fundamental purpose of publishing technical papers for free discussion.

A year has passed since the Society's members voluntarily placed themselves and their experience on record with the Federal Government, through the medium of their Society, in the National Roster of Specialized Personnel. Other efforts of the Society have been progressing on the same scale. The Society has published a manual of engineering practice on "Military Highways in Forward Areas," and recently a report of the Committee on Civilian Protection in War Time. But almost transcending in importance these more obvious activities is the Society itself—a reservoir of professional knowledge which is a genuine national resource. Through the medium of its technical publications it sifts out the good from the bad in technical procedures and tests and makes a record of its findings that would be sorely missed if the country were forced to go without it.

This is just another way of reiterating the importance, and in fact the urgent need, of constant discussion of technical papers by qualified members of the Society. What civil engineers do and think is published in the Society's journals. Some of it is good, but not necessarily all of it. Therefore if research in civil engineering is to be truly a national resource, readers of these technical papers must present for the benefit of the profession any material they may have gathered which would alter or amplify the findings of the author.

Here is a project that should appeal to all who suffer from a sense of the futility of their contribution to the needs of the nation in this time of emergency. Now more than ever, constructive research, carefully sifted by critical eyes and minds, is a national resource.

Joseph Jacobs, 1869–1942

WORD has just been received of the sudden death in Seattle on March 16, of Joseph Jacobs, M.Am. Soc. C.E. This news was a shock to his wide circle of friends, many of whom saw him as recently as January, when he attended the Annual Meeting of the Society.

Following his graduation from Kansas State University in 1889, Mr. Jacobs was for a few years with the Geological Survey. Following this he was for 12 years in railroad work in the West, and for 5 years in irrigation practice, largely with the Reclamation Service. In 1910 he opened a consulting office in Seattle, which has been continued with only one interruption, when he served as Major of Engineers for two years in France during the World War.

JOSEPH JACOBS

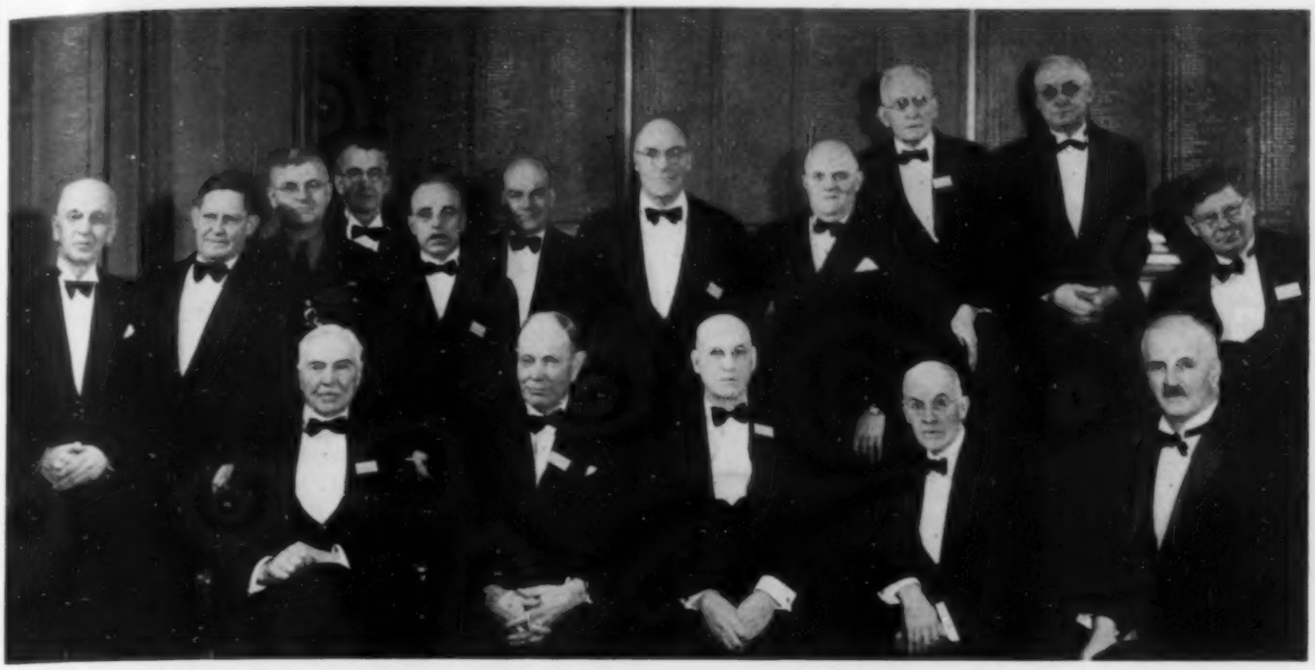
In all engineering matters, particularly those dealing with the use of water, Major Jacobs was well known. He also interested himself in civic matters around Seattle, including the state and the city chambers of commerce.

In the Society, he was chairman of the Irrigation Division in 1926 and 1927, Director from District 12, 1929–1931, and Vice-President for 1940–1941. He also served as president of the Seattle Section. In all these services he gave generously of time and effort.

George W. Burpee Appointed Assistant Treasurer of Society

ANNOUNCEMENT has been made of the appointment of George W. Burpee, M. Am. Soc. C.E., as assistant treasurer of the Society. He will replace Ralph Rumery, M. Am. Soc. C.E., who has resigned.

Spring Meeting, Roanoke, Va.—April 21–23, 1942. See Program in this issue.



CANADIAN AND AMERICAN ENGINEERS AT FIFTY-SIXTH ANNUAL MEETING OF ENGINEERING INSTITUTE OF CANADA

Left to Right, Front Row: Dr. A. H. White, President, Society for the Promotion of Engineering Education; Ernest B. Black, President, American Society of Civil Engineers; Dr. Eugene McAuliffe, President, American Institute of Mining and Metallurgical Engineers; George T. Seabury, Secretary, American Society of Civil Engineers; Dr. C. J. Mackenzie, Immediate Past-President, The Engineering Institute of Canada; Back Row: C. R. Young, President, The Engineering Institute of Canada; A. B. Parsons, Secretary, American Institute of Mining and Metallurgical Engineers; C. E. Davies, Secretary, American Society of Mechanical Engineers; H. H. Henline, Secretary, American Institute of Electrical Engineers; S. L. Tyler, Secretary, American Institute of Chemical Engineers; James W. Parker, President, American Society of Mechanical Engineers; D. C. Prince, President, American Institute of Electrical Engineers; S. D. Kirkpatrick, President, American Institute of Chemical Engineers; Prof. Charles F. Scott, Chairman, Committee on Professional Recognition, Engineers' Council for Professional Development; C. C. Knipmeyer, President, National Council of State Boards of Engineering Examiners; J. A. Van den Broek, Professor of Engineering Mechanics, University of Michigan, Ann Arbor.

Annual Report Measures E.C.P.D. Progress

THOSE who have any question as to the substantial contribution being made to the profession by the Engineers' Council for Professional Development need only glance over the latest annual report. It deals with the Council's business year ending September 30, 1941.

By a series of reports and many statistics, it clearly pictures a variety of interests and no small measure of successful accomplishment. All the Council's committees have reported independently. Similarly the constituent organizations—the Society and seven other bodies—include brief reports. Statistics of finances, of personnel, of governing procedures, and of publications complete this 48-page pamphlet.

Much concentrated effort has gone into this work and many men of high ideals have contributed. The result marks another step forward for the Council. Members of the Society will find much of interest in it. Copies may be obtained from the Council by addressing the Secretary at 29 West 39th Street, New York, N.Y.; the cost is 25 cents.

Conference on Aerial Bombardment Protection

As previously announced in these pages, a National Training Conference on Aerial Bombardment Protection was held in New York City, February 16–24, 1942. All sessions were in the Engineering Societies Building. About 300 engineers and architects gathered from various parts of the country. The Pacific Coast was well represented and similarly the Mississippi Valley, while eastern engineers predominated. Three of those in attendance came from Puerto Rico.

This course of lectures and discussions was intended to give concentrated information to those responsible for protection measures in their own cities. Causes, results, and civilian, structural, and utility problems involved were explained to those who attended.

As might be expected, many of the representatives were civil engineers responsible for municipal structures, plants, or public services. Then there were representatives from many of the Society's Local Sections, connected with the activities of the National Committee on Civilian Protection in War Time. Another large group consisted of civil engineering teachers who were preparing themselves to teach independent courses in these subjects in their respective communities. The net result was that the conference took on the appearance, partially at least, of a Society gathering.

Joint sponsors of this most successful conference were the U.S. Office of Civilian Defense, the U.S. Office of Education, and New York University's College of Engineering. Most of the sessions were under the direction of Prof. Harold E. Wessman, M. Am. Soc. C.E.

Symposium on Cost of Power Now Available

FOR A NUMBER of years the Power Division and the Engineering Economics Division have sponsored jointly a widespread discussion of problems relating to the cost of power. This program began as a cooperative effort at the 1936 Fall Meeting of the Society in Pittsburgh, Pa., when the first symposium of five papers on the "Economic Aspects of Energy Generation" was presented. The second symposium of six papers, on "Cost of Energy Generation," was presented in January 1938 at the Annual Meeting of the Society in New York.

Originally it had been planned to present a third symposium, on "Cost of Power to the Consumer," and publish the three consecutively in one volume of TRANSACTIONS. As time passed, however, it became evident that the first two, already published, should be made available without further delay as a separate pamphlet for the everyday use of members interested in this vitally important subject.

This 270-page book has now been collated and a few hundred copies bound in pliable cardboard covers. It represents the work of 11 authors and 35 critical discussers and is offered at a standard price of $2.60 per copy. The usual discount of 50% is allowed to members. If and when the third symposium appears and has run its course in discussion, it is planned to issue it as a supplement to the present volume.

Society's Roanoke Meeting April 21-23 Offers Attractions

A SPLENDID meeting has been arranged for Roanoke, Va., for April 21-23. Details will be found in the official program on other pages. The arrangements should appeal to many members and attract a large attendance in keeping with the excellence of the program.

Roanoke was chosen as being convenient to those living in the eastern half of the country. Located in the beautiful country of western Virginia, it is available by railroad and highway from all directions. For example, it is about equidistant from Detroit, Atlanta, and New York. Those who know the Blue Ridge country in the spring time will need no further inducement.

In keeping with the spirit of the times, the meeting is relatively compact. It will include a Local Sections Conference and various committee sessions. Many prominent engineers and Government officials are listed as speakers. These commitments are obviously contingent on developments in the war emergency. Social events are fewer than normal, as this meeting has been designed specifically to make a real contribution to the engineering thought of the country in war time. Not the least of its attractions is the hospitality of one of the most noted hotels of the region. Visitors may expect a fine meeting in congenial and comfortable surroundings. The detailed program of sessions and trips appears on pages 217–222 of this issue.

Library Reduces Service Fees to Members

FOR several years members of the Society have enjoyed the privilege of borrowing books from the Engineering Societies Library. Many have made use of this service, and books are being sent in increasing number to all parts of the country. To make the service still more attractive, the Library Board has just modified its rules by reducing the fee charged to cover mailing and the other costs involved in the service.

Under the new rules, the charge is 25 cents a volume for each week that the book is kept, and books will be sent upon request to members anywhere in the United States or Canada. Except for rare and irreplaceable books and such purely reference works as dictionaries and handbooks, all treatises and textbooks are available for this service.

Appointments of Society Representatives

WILLIAM H. CHORLTON, DUDLEY T. CORNING, and LAURENCE B. MANLEY, Members Am. Soc. C.E., have been appointed Society delegates to the annual meeting of the American Academy of Political and Social Science, to be held at the Benjamin Franklin Hotel, in Philadelphia, on April 10 and 11.

ALONZO J. HAMMOND, Past-President Am. Soc. C.E., has been appointed one of the Society's representatives on the John Fritz Medal Board of Award to fill the vacancy caused by the death of DONALD H. SAWYER, Past-President Am. Soc. C.E. Colonel Sawyer's term would have expired in October 1943.

ENOCH R. NEEDLES, M. Am. Soc. C.E., has been reappointed one of the Society's representatives on the Hoover Medal Board of Award for the six-year term ending in May 1948.

News of Local Sections

Scheduled Meetings

ALABAMA SECTION—Dinner meeting at Auburn on April 6, at 7 p.m. (Joint meeting with the Student Chapter at Alabama Polytechnic Institute.)

ARIZONA SECTION—Spring meeting at the Pioneer Hotel on May 2, at 10 a.m.

CENTRAL OHIO SECTION—Luncheon meeting at the Fort Hayes Hotel on April 16, at 12 m.

CLEVELAND SECTION—Joint meeting with the North Central Conference of Student Chapters at the Tudor Arms Hotel on April 16, at 6:30 p.m.

FLORIDA SECTION—Meeting at the time of the meeting of the Florida Engineering Society in Tampa, April 23, 24, and 25.

ILLINOIS SECTION—Joint dinner meeting with the Juniors of the Section at the Chicago Lighting Institute, Civic Opera Building, 20 North Wacker Drive, Chicago, on April 6 (dinner at 6:30 p.m., program at 8 p.m.); dinner meeting of the Junior Section at the Central Y.M.C.A., Chicago, on April 20 (dinner at 6 p.m., program at 6:45 p.m.).

LOS ANGELES SECTION—Dinner meeting at the University Club on April 8, at 6:15 p.m.

METROPOLITAN SECTION—Meeting in the Engineering Societies Building on April 15, at 8 p.m.

MIAMI SECTION—Dinner meeting at the Alcazar Hotel on April 2, at 7 p.m.

NASHVILLE SECTION—Dinner meeting at Vanderbilt University on April 7, at 6:15 p.m.

NORTHEASTERN SECTION—Dinner meeting at the Engineers' Club on April 15, at 6 p.m. (Joint meeting with the Boston Society of Civil Engineers.)

NORTHWESTERN SECTION—Dinner meeting at the Minnesota Union on April 6, at 6:30 p.m.; dinner meeting of the Junior Chapter at the Bryan Tea Room on April 20, at 6 p.m.

PHILADELPHIA SECTION—Joint dinner meeting with the Engineers' Club of Trenton at Trenton, N.J., on April 9, at 6 p.m.

SACRAMENTO SECTION—Regular luncheon meetings at the Elks Club every Tuesday at 12:10 p.m.; dinner meeting of the Junior Forum at Hart's Restaurant on April 8, at 6 p.m.

SAN FRANCISCO SECTION—Dinner meeting at the Engineers' Club of San Francisco on April 21, at 5:30 p.m.

SEATTLE SECTION—Dinner meeting at the Engineers' Club on April 27, at 6:30 p.m.; joint meeting with the University of Washington Student Chapter (program to be arranged by students).

SPOKANE SECTION—Luncheon meeting at the Davenport Hotel on April 10, at 12 m.

TACOMA SECTION—Dinner meeting at the Lakewood Community Center on April 14, at 6:30 p.m.

TEXAS SECTION—Luncheon meeting of the Dallas Branch at the Dallas Athletic Club on April 6, at 12:10 p.m.; luncheon meeting of the Fort Worth Branch at the Blackstone Hotel on April 13, at 12:15 p.m.

UTAH SECTION—Dinner meeting at the Beau Brummel Restaurant on April 1, at 6:30 p.m.

WEST VIRGINIA SECTION—Spring meeting at Charleston, W.Va., on April 3.

Wisconsin Section—Joint dinner meeting with the Engineers' Society of Milwaukee at the Stratford Arms on April 15, at 6:30 p.m. (meeting will be at Marquette University at 8 p.m.).

Recent Activities

Buffalo Section

On February 17 members of the Buffalo Section heard Charles R. Waters discuss the subjects, "Manufacturing and Reconditioning Highway Signs," and "The Use of Blackout Markings on Highways." Mr. Waters, who is district engineer of the Public Highways Division of the New York State Department of Public Works, illustrated his talk with slides showing a sign-manufacturing plant at Hamburg, N.Y. He pointed out that a special rust-resistant steel, developed by the Bethlehem Steel Company, is being used for these signs. Mr. Waters then discussed types of paints and machinery employed in marking highways for driving during blackouts. A general discussion of luminous paints for such use and a demonstration of phosphorescent and fluorescent materials concluded the meeting.

Cincinnati Section

A joint meeting of the Section, the local branch of the American Society of Mechanical Engineers, and the Engineers Club of Cincinnati took place on February 26. The feature of the occasion was a talk on "Bridges and Aerodynamics," given by D. B. Steinman, New York consultant. Dr. Steinman supplemented his talk with motion pictures of the Tacoma Narrows Bridge failure and demonstrations and models showing the effects of wind pressure on different models and surfaces.

Colorado Section

At the meeting held on February 9 John C. Fleming, of the Mountain States Telephone and Telegraph Company, presented two motion pictures showing the company's current activities. The first of these, entitled "Voice Ways Over the Rockies," pictured the construction of a new line over the 12,000-ft Loveland Pass in Colorado. The second film showed the numerous ways in which the telephone aids in the national emergency. A film produced by the Intelligence Service of the Army concluded the technical program. The latter film pointed out the necessity for discretion if enemy agents are to be kept from obtaining vital information.

Illinois Section

A symposium on "Civilian Protection in War Time" was the feature of the joint meeting of the Section and the Chicago Engineers Club, which took place on February 24. Those participating in the program were Col. B. B. Freud, assistant regional director of the Sixth Corps Area in charge of civilian defense; Ralph H. Burke, Philip Harrington, and Otto Jelinek, respectively deputy coordinator, chief of communications, and chief of technics for the Office of Civilian Defense; W. W. De Berard, city engineer of Chicago; and T. L. Condron, Chicago consultant. The latter had just returned from New York, where he was the Section's representative at the National Training Conference on Aerial Bombardment Protection.

Indiana Section

At a dinner meeting held on February 13 Capt. Kenneth E. Kline discussed the subject of preventing sabotage of public utilities and public buildings. Condemning an attitude of hysteria on the subject, Captain Kline nevertheless pointed out the desirability of "a reasonable preparation" against sabotage. Three general forms of protection he cited were guarding against fires, careful police guards, and well-conducted safety schools. In general, he said, if there seems any threat of sabotage, the person who has cause for suspicion should get in touch with the F.B.I. Protection against sabotage is 75 per cent a personnel job, and 25 per cent mechanical, he contended. During the annual business meeting the following new officers were elected: Ben H. Petty, president; M. R. Keefe, vice-president; and Denzil Doggett, secretary-treasurer.

Iowa Section

The Iowa Section held two meetings in February. At one of these the Section's prizes of Junior membership in the Society were presented—to Victor Greimann, of Iowa State College, and Warren F. Burger, of Iowa State University. The technical program on this occasion consisted of talks by Ivan P. Hanson, resident engineer for Howard, Needles, Tammen and Bergendoff, who discussed "Construction Problems on the Dubuque Bridge"; and M. G. Spangler, research associate professor of civil engineering at Iowa State College, whose subject was "The Energy Concept of Soil Moisture and the Mechanics of Unsaturated Flow." Later in the month there was a dinner meeting at which Hardy Cross, professor of civil engineering at Yale University, spoke on the subject, "What Is Civil Engineering."

Ithaca Section

The speaker at the January meeting of the Ithaca Section was Prof. Leonard A. Lawrence, who discussed "Surveying at High Speed." Professor Lawrence described particularly the methods used on the preliminary surveys at the site of a proposed chemical plant in Alabama. On February 10 there was a joint meeting with the Cornell University Student Chapter. On this occasion Ole Singstad, chief engineer of the New York City Tunnel Authority, spoke on the subject of the Brooklyn Battery Tunnel. Earlier in the day Mr. Singstad had given a special talk on "Subaqueous Tunnel Construction" for the Student Chapter and civil engineering faculty.

Kansas City Section

A special dinner meeting in honor of E. B. Black, newly elected President of the Society, was held by the Kansas City Section on February 14. The large turnout of members and guests included the mayor of Kansas City, who greeted Mr. Black as an alumnus of the University of Kansas and welcomed him in the name of Kansas City. Testimonial talks were given by H. Roe Bartel, Boy Scout executive of Kansas City (Mr. Black was for several years president of the Boy Scout Council), and T. J. Strickler, vice-president of the Kansas City Gas Company. Dr. E. E. Howard then reminisced about the many distinguished engineers in and around Kansas City. Local Section President William M. Spann presided at the meeting, and Robert P. Woods was in charge of the program.

Kentucky Section

The Kentucky Section held a joint meeting with the Kentucky Society of Professional Engineers at Lexington on January 23. A joint luncheon initiated the day's events. Speakers at the luncheon and afternoon session included A. S. Meyer, professor of mechanical engineering and director of the Aeronautical Research Laboratory at the University of Kansas, who spoke on the history and development of airplane engines; H. K. Moss, special agent in charge of the Louisville Office of the F.B.I., who discussed the personnel, problems, and performance records of his organization; J. J. Greenleaf, state director of civilian defense, who addressed the gathering on defense utilities, railroads, and other forms of public service; Col. C. H. Menger, of the Lexington Signal Corps Depot, whose subject was trade unionism in the profession; and R. H. Coleman, state director of the Public Work Reserve, who outlined the history of his organization and suggested long-range planning for post-war conditions. The program concluded with a talk by Edward Larson, executive secretary of the National Society of Professional Engineers, whose subject was "The Professional Engineer and National Defense." The evening session opened with a banquet, which was addressed by the Hon. Keen Johnson, Governor of Kentucky.

Los Angeles Section

Several timely talks were presented at the February meeting of the Section. The first speaker on the program was Harald Omsted, chief engineer for Paramount Pictures, Inc., who discussed air raid shelters. Mr. Omsted, who was in Norway at the time of the German invasion, also described his experiences there. Next on the program was Capt. T. George Hazenbush, camouflage officer for the U.S. Engineer Office at Los Angeles, who spoke on the camouflage of industrial plants, stating that a large number of preliminary studies is required before an effective program can be undertaken. He mentioned the fact that camouflage is extremely costly and pointed out the fact that many structures do not warrant such expense. Royal Leonard, who has been in China serving as personal pilot to Chiang Kai-Shek, discussed flying conditions in China and described the personalities of General and Madame Chiang Kai-Shek. A talk on the subject, "Oil for the Axis," concluded the program. This was given by William T. Foran, geologist for the Standard Oil Company, who stated that the first conflicts

with Germany over oil took place in South America as early as 1924. It is Mr. Foran's opinion that Germany will be beaten if the Allies can keep her out of Irak and the Russian Caucasus.

Maryland Section

Discussion of civilian protection during aerial bombardment occupied much of the technical session at the March 3 meeting of the Maryland Section. Following a report on the National Training Conference recently held in New York, it was announced that a series of six or eight lectures on civilian protection will be given at Johns Hopkins University beginning early in April. A moving picture entitled "Fighting the Fire Bomb" was then shown. A representative of the De Walt Saws Company presented a film depicting the construction of a large army camp.

Metropolitan Section

"Geologic Features of the Delaware Water System" was the subject of discussion at the February meeting of the Metropolitan Section. The scheduled speakers on this program were Paul H. Bird and John M. Fitzgerald, respectively assistant geologist and department engineer for the New York Board of Water Supply. The former described the interesting and complex studies undertaken before and during the construction of the Delaware system, while Mr. Fitzgerald presented an illustrated paper on the methods employed in the construction of the Delaware Aqueduct, where geologic conditions involved certain departures from usual construction methods. He stressed the value of advance knowledge of unusual subsurface conditions in planning the work and in combatting untoward events as the work progressed. Considerable general discussion followed the formal presentations.

Mohawk-Hudson Section

On January 29 members of the Mohawk-Hudson Section heard John J. Farrell, Deputy Director of Civilian Defense in New York State, explain the program of civilian defense as it is at present operating. He spoke of the many difficulties that are being encountered and overcome as well as some possible changes in the legislation now controlling the operation of defense agencies in New York State. The role of the engineer in civilian protection was emphasized by Mr. Farrell. A general discussion concerning many phases of the civilian protection problem, including the communication and transportation difficulties that might be expected to exist, followed his talk. A buffet supper was enjoyed at the close of the technical program.

Philadelphia Section

The army's construction program in 1941 was discussed at the January 13 meeting of the Philadelphia Section. Both of the speakers—Lt. Col. Joseph H. Burgheim, Corps of Engineers, U.S. Army, and Francis Friel, Philadelphia consultant—paid tribute to the accomplishments of the engineering profession and construction industry in our present defense activities. Colonel Burgheim discussed some of the engineering and construction problems that have been met in providing housing and other necessary facilities for the expanding army. At the conclusion of his talk he showed a color film of the entire construction process at Camp Polk, La. Mr. Friel then read his paper on the design and construction of Camp Rodman, Md., which consists of more than 400 buildings containing approximately two million square feet of floor space and is serviced by 75 miles of utilities. A special dinner meeting to honor President Black was held on January 28. Mr. Black spoke on current events as affecting the engineering profession, and Society affairs were discussed by Secretary Seabury, retiring Director Sanford W. Sawin, and newly elected Director Scott B. Lilly. The meeting was then thrown open to general discussion of civilian protection and other timely matters.

The seventeenth annual social meeting of the Section, which was held on February 21, was designated "Pan-American Night." The attendance of 124 included Secretary Seabury, Vice-President Stevens, and Director Lilly. Following a dinner and group singing Lyle Jenne, as master of ceremonies, presented a program of dancing and musical novelty numbers. Later two travel films—of journeys to Iran and Afghanistan—were shown through the courtesy of the Standard Oil Company of Pennsylvania.

Pittsburgh Section

On January 29 the Section gave a dinner in honor of its new life members from the region—Director C. G. Dunnells, Edward Godfrey, E. K. Hiles, N. F. Hopkins, and S. C. Hulse. Later in the evening the Section met jointly with the Civil Section of the Engineers Society of Western Pennsylvania. A symposium on "Building Small Naval Vessels in a Commercial Barge Plant" comprised the technical program. The speakers were George F. Wolfe, of the Dravo Corporation, and Lt. Robert Hughes, of the U.S. Naval Reserve.

Sacramento Section

The Sacramento Section reports that the customary weekly luncheon meetings have been enjoyed during the past two months. The list of speakers scheduled for these occasions includes Clinton J. Duffy, warden of San Quentin Prison, who gave a résumé of the history, development, policies, and activities of this institution; J. J. Gould and H. B. Hammill, members of a committee appointed by the San Francisco Section to investigate the timber arches and plywood panel construction used at the San Francisco Exposition, who gave an illustrated lecture on "Tests of Treasure Island Timber Elements"; John S. Walsh, illumination engineer for the Pacific Gas and Electric Company, who discussed blackout problems; E. W. P. Smith, whose subject was "Welding During and After the War"; and Samuel R. Leedham, who gave an illustrated lecture on the Dutch East Indies. Mr. Leedham has recently been in both the Philippines and the Indies, and his talk was very timely. Special Section events included the annual dinner dance, which was held on January 16.

St. Louis Section

At the meeting held on February 24 Juniors of the Section were in charge of the program, which consisted of an informal debate on the subject of labor union affiliation. V. A. Silber and E. M. Johnson spoke in favor of unionization for engineers, while O. H. Walker and O. A. Ray took the negative side. A lively discussion from the floor followed. The Section met jointly with the Engineers' Club of St. Louis on March 5 to hear James E. Frick, sales manager for the Potts Electric Signal and Manufacturing Company, discuss the photoelectric eye. The extreme adaptability of this device to almost any condition, and the unlimited possibilities of use were thoroughly brought out. Important among present-day applications of the device is its use to guard against sabotage. Working models of various installations of the photoelectric eye and other automatic control and alarm devices were demonstrated and explained, and motion pictures of some of them in action were shown.

San Francisco Section

The technical program, presented at the meeting held on February 17, consisted of the showing of colored motion pictures of work of the U.S. Army in the construction of Camp Cooke in California, the Oakland Port of Embarkation, and Salinas Dam. The projects were then discussed by Lt. Col. E. J. Walters, area engineer for the Port of Embarkation; Captain Covert, utilities officer at Letterman Hospital; and Harry W. Dennis, principal engineer in the office of the District Engineer. On February 27 the Section sponsored the annual joint meeting of the member societies of the San Francisco Engineering Council. "Gold vs. Strategic Materials" was the topic of discussion—presented by D. H. MacLaughlin, dean of mining and dean-elect of the engineering schools of the University of California.

At the January meeting of the Junior Forum Victor Sauer, sanitary engineer for the City of Oakland, gave a talk on "Drainage and Sanitation Problems," and F. L. Weiss described the design and construction of the Union Square Garage in San Francisco. The latter's talk was illustrated with colored slides. The subject for open discussion was "What Can We Do to Aid in the National Defense Program?"

Tri-City Section

Speakers at the regular meeting of the Tri-City Section—held in Davenport, Iowa, on February 20—were H. B. Christianson, division engineer for the Chicago, Milwaukee, St. Paul and Pacific Railroad, at Savanna, Ill., and Mark B. Morris, traffic engineer for the Iowa State Highway Commission. The former discussed track problems in connection with the operation of streamliners, pointing out that the radius of curvature of the track was the major factor controlling the maximum speed of modern passenger trains. In a talk on "Modern Highway Transportation," Mr. Morris discussed the concurrent development of automobiles and highways and stated that this development has reached a stage where possible speeds are in excess of those with which the average driver is competent to cope.

Utah Section

On February 25 members and guests of the Utah Section heard Ralf R. Woolley speak on "Water and Community Growth." Mr. Woolley, who is hydraulic engineer for the U.S. Geological Survey at Salt Lake City, outlined the history and development of Salt Lake City and Utah in relation to water supply. He maintains that future developments will be definitely limited by lack of water. Several charts were presented to show methods of forecasting population, and variations in the curves were explained. An enthusiastic general discussion followed his talk.

Virginia Section

"The war is a race for the mobilization of the resources of the world and to convert them into raw materials. Already the Axis powers have a head start," William Shands Meacham told members of the Virginia Section at their annual dinner meeting which was held in Richmond on February 13. He warned that democracy cannot live in the luxury to which it has become accustomed and expect to defeat "the most powerful military combination in history." Another feature of the dinner was the presentation of certificates of life membership to Henry R. Hortenstine and Walter Rowland. During the afternoon technical session papers were presented by D. W. Schumaker, of the University of Virginia Student Chapter, and Cadet W. E. Emory, of the Virginia Military Institute Chapter. There was also a talk by Hugh R. Pomeroy, director of the Virginia State Planning Board, who gave an illustrated lecture on the Richmond Civil Center. His talk was discussed by Gamble M. Bowers, Director of Public Works of Richmond. During the annual business meeting the following officers were elected for the coming year: E. S. Thomas, president; and W. R. Glidden, T. W. Roby, and Richard Messer, vice-presidents. The secretary-treasurer remains P. A. Rice.

Student Chapter Notes

Polytechnic Institute of Brooklyn

The Student Chapter at the Polytechnic Institute of Brooklyn reports that its annual inspection trip, which consisted of a tour of some of the civil engineering plants and projects in the East, was highly successful. The accompanying photograph shows the group at St. Georges, Del., where they witnessed the erection of the St. Georges Bridge.

Brooklyn Polytechnic Institute Group at St. Georges, Del.

Syracuse University

Motion pictures were enjoyed at several recent meetings of the Syracuse University Student Chapter. On one occasion a film telling the story of the production of steel from the blast furnace to the finished product was shown through the courtesy of the Bethlehem Steel Company. At another meeting there was a moving picture of the local sewage treatment plant and the various problems of operation.

New York University

Bombproof construction was discussed by W. A. Rose, assistant professor of structural engineering at New York University, at a meeting of the Evening Division of the Chapter held on February 25. The lecture, which was illustrated with slides, was a review of a course in the principles of bombproof construction that Professor Rose is giving at the present time for teachers from other colleges.

Missouri School of Mines

At a recent meeting of the Missouri School of Mines Student Chapter J. B. Goetz, structural engineer for the Portland Cement Association, gave an illustrated lecture on "New Developments in the Use of Concrete." Mr. Goetz pointed out that the barrel shell roof—a very thin roof slab spanning a long distance—is a new idea in the field of concrete design. Railway companies, he said, have found it feasible to use concrete to stabilize marshy land, and railway beds are often placed on slabs in order to make the stresses more uniform. Mr. Goetz also pointed out that in mining operations concrete columns have replaced many of the old wooden types, while concrete mixed with micalite makes a highly satisfactory insulator for heat and sound. The accompanying photograph shows the Student Chapter with Mr. Goetz and Faculty Adviser E. W. Carlton.

Members of Missouri School of Mines Student Chapter

ITEMS OF INTEREST

About Engineers and Engineering

Civil Engineering for May

Describing an "Army Cantonment Built in Sub-Zero Weather," Daniel B. Niederlander, vice-president and general manager of the John W. Cowper Company, of Buffalo, gives interesting details of a $16,000,000 project. In spite of intense cold and heavy snow, the buildings, roads, sanitary facilities, and all other details were successfully completed. In the words of a high Army official, it was "an especially fine example of good planning and execution."

An entirely different type of project is described in a paper on "Flood Control for the Yazoo Valley, Mississippi" by George A. Morris, Assoc. M. Am. Soc. C.E. He discusses the studies which led to the adoption of a plan calling for four headwater reservoirs together with levees, channel regulation, and a large retarding basin in the main valley. The paper gives a brief yet thorough treatment of this important engineering study.

So much of the East River Drive in New York City is adjacent to the pier line that a combined parkway and bulkhead construction had to be adopted. The design and construction of this new type of relieving platform bulkhead are described by Lester C. Hammond, M. Am. Soc. C.E. An essential feature is a steel sheet-pile diaphragm to hold the fill, tied back to heavy concrete anchors for lateral stability. The $10,000,000 job represents a definite advance in water-front construction.

Methods of designing structural parts or assembly are continually receiving attention by engineers. A paper by Raymond D. Mindlin, Assoc. M. Am. Soc. C.E., deals with the "Present Status of Three-Dimensional Photoelasticity." His description of the various methods in vogue, with the principles on which they depend, and their application to many types of problems, makes worth-while reading. It deals with one part of an important field that is all too little understood by the average engineer.

Suggestions for Civil Engineers Inducted Into the Army

By Shelby A. McMillion

Captain, Corps of Engineers, U.S. Army

Assume that you, a civil engineer, are entering military service. The normal procedure when you are inducted is to spend one day at the Induction Station and then be sent to a Reception Center, where the various details incidental to receiving you into the service are completed. This may take as much as a week. During this time uniforms will be issued, personnel records initiated, and you will be classified according to your special education and experience.

It is especially important, at the Reception Center, to provide the interviewing officer with full information on your education and experience. It is usual for men to be sent from the Reception Center to a Replacement Training Center for basic instruction in a specific branch of the service. All branches of the service maintain such training centers, and if you wish to be in the Corps of Engineers you should state your preference and ask to be sent to an Engineer Replacement Center. While it is not always possible to send men to the branch of the service that they prefer, you should make sure that your preference is known. In some instances, enlisted men are taken directly from the Reception Center to training divisions, but the Replacement Training Center procedure is normal.

The War Department has announced a large increase in the number of Officer Candidate Courses, available to enlisted men. The age limits for these courses have been broadened to include men between 18 and 45. Application for selection as an Officer Candidate may be submitted by an enlisted man at any time. However, it is not possible to attend an Officer Candidate Course until you have served at least three months in the Army. Candidates for officer training are then selected on the basis of demonstrated ability. The commanding officer of the unit to which you are assigned will be able to provide full information on how to apply for the Officer Candidate Courses.

One of the most important attributes of an officer is his ability to lead. No individual, regardless of his educational background, will be selected as an officer candidate unless he has demonstrated this ability to his superiors. Candidates are put through an intensive three months' course of instruction where the standards of performance are extremely high. Long hours, hard work, and strict application to duty are necessary in order to graduate from the Officer Candidate Schools.

Successful officer candidates are commissioned as second lieutenants in the Army of the United States. In some instances, exceptionally well-qualified men who are over-age for duty with troops as second lieutenants will have an opportunity for further advanced training. Upon demonstration of ability they can be promoted to higher grades more in keeping with their age.

N. G. Neare's Column

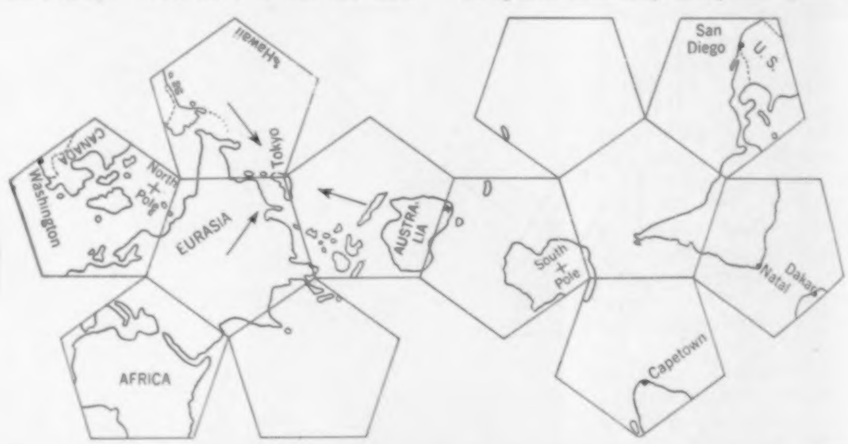
Conducted by

R. Robinson Rowe, M. Am. Soc. C.E.

"If we only had the wishing-cap of Fortunatus, we'd now have 12 S-C (super-colossal) air bases dispatching thousands of B-19 bombers to ride herd on the whole earth. Three in particular would be running an hourly parcel post of 'bundles for Charlie' to Hirohito's home town, dumping their mail without benefit of customs. But we haven't the wishing-cap or Aladdin's lamp. We'll have to win the hard way, with brawn and blood and brain and bonds."

Indulging in this prophetic fancy to gather the attention of the Engineers Club, Professor Neare continued. "Remembering that these bases were to enjoy complete coverage of the earth with a minimum bomber range, how did Aaron Ottix dispose them?"

"I'm probably wrong as usual," ventured Joe Kerr, "but I figured the bombers would have a cruising radius of 3,210 miles, if two bases were at the poles and 10 spaced uniformly along the equator."



Roanoke Welcomes you for Spring Meeting, April 21–23. See official Program for full details.

"You're right, you're wrong. Aaron did much better."

"Did he do as well as 2,585.947 miles?" asked Cal Klater.

"Just so well," conceded the Professor. "So how were the bases arranged?"

"As points of tangency of the faces of a regular dodecahedron circumscribed about the given flight sphere ($r = 3{,}964$). Since each face is a regular pentagon, each base will cooperate with five neighboring bases 4,389 miles away. If the dodecahedron is so disposed that Tokyo is the radial projection of one of the trihedral vertices, then three bases can just attack it with an effective pay load of 'bundles for Charlie.'

"By the required conditions, one base must be due south of Tokyo, near the coast of New Guinea. The second spear head will be aimed from Kabdab in the Gobi Desert and the third from a floating S-C base in the North Pacific."

"Precisely," agreed Professor Neare. "Here is Aaron Ottix's map of the world, charted by developing the dodecahedron on which the globe has been projected radially. He calls it the Dodecahedrottix Projection and recommends the system as that by which the world can be represented by 12 edge-matching maps with a minimum of distortion."

"I'll buy one, Noah, when it's revised after the war," offered Haddah Nipp, the explorer.

"Sold. Now for a hydraulic teaser, encountered by hydrokinematist M. T. Tank while designing air-raid-emergency fire-fighting equipment. Given two 1,000-cu-ft water tanks—one spherical and the other cubical—which can be emptied more quickly, if each be fitted with top vent and bottom orifice of the same effective size ($C_dA = 0.1$ sq ft)? If that sounds too easy for you experts, M. T. would like to know the ideal shape for a quick-emptying tank, under those same conditions."

(Richard Jenney and Weston Gavett located all 12 S-C bases with great precision, but the tabulations are guarded as military secrets until after the war. Other solutions were good but not good enuf.)

Navy Seeks Civil Engineers for Commissions in Naval Reserve

Requirements for appointment as Ensign in the Civil Engineer Corps Reserve of the Navy have been revised to attract more men to the U.S. Navy. Heretofore graduates with a scientific degree had to have a minimum of three years of active engineering practice subsequent to their graduation. Now men with limited practical experience who have graduated from accredited colleges and universities from the classes of 1941 and previous years and who have received degrees in civil engineering, mechanical engineering, electrical engineering, and architectural engineering, are being offered the opportunity of applying for a commission in the Naval Reserve.

It is estimated that between two hundred and three hundred additional reserve officers will be needed to complete the war expansion program. All college graduates who believe themselves qualified are urged to make application to the Commandant of the Naval District in which they reside.

Research Fellowships—Purdue University

Announcement has been made of a number of research fellowships available on the Joint Highway Research Project at Purdue University, starting in May, August, and January of each year. Under the new three-term plan in effect at Purdue University, part-time graduate assistants will be able to secure a master's degree in twelve months. At the same time they will be paid at the rate of $70 per month as long as they are in school on a part-time basis, or at the rate of $125 per month for full-time research work. In the latter case they will be able to take six hours of graduate work.

Applicants are required to have a bachelor's degree in civil engineering, and to submit a detailed letter of application. They should be good students interested in research. Inquiries may be addressed to the Joint Highway Research Project, Civil Engineering Building, Purdue University, Lafayette, Ind.

Commissions in Marine Corps for Engineers

The United States Marine Corps contemplates the early commissioning of approximately 35 civil engineers in the Marine Corps Reserve, for duty in engineer organizations of the Marine Corps. These prospective officers should be between the age limit of 25 and 40. A few will be commissioned as majors, a few more as captains, and the majority as first lieutenants.

The types of engineering work anticipated are principally those calling for civil engineering training and experience. However, a few mining, mechanical, and electrical engineers are desired. The type of work to be done is the usual military engineering, consisting of hasty temporary construction of roads, bridges, and air fields as well as demolition work, road repair, water supply installation and operation, surveying, map making and reproduction, and similar tasks.

Applicants for commissions in the Marine Corps Reserve should have engineering degrees and should have a minimum of two years' practical experience in engineering after graduation from school. They must be citizens. Previous military experience is desired but is not a prerequisite for a commission.

The Commandant of the U.S. Marine Corps has asked for the assistance of the Society in locating qualified men to commission in the Marine Corps Reserve for active duty in the Marine Corps. Interested persons should apply direct by personal letter to the headquarters of the U.S. Marine Corps addressed to: The Director, Marine Corps Reserve, Washington, D.C.

Prize Papers on Arc Welding

Shortly the current competition of the James F. Lincoln Arc Welding Foundation will be closed. Under the title of "Progress Program," this competition is to secure papers describing experiences and lessons which indicate the advantages of modern arc welding, not only in war production but also in peacetime pursuits. A total of $200,000 is to be distributed in prizes.

It will be remembered that a somewhat similar program under the same auspices was conducted in 1937–1938. Many engineers participated and a number of members of the Society gained recognition and financial prizes. In the current contest, 458 awards are to be made, ranging from a maximum of $13,700 to a minimum of $100.

As previously announced in these pages, the program closes on June 1, 1942. Although the time is getting short, those interested still have time to obtain the rules and regulations and enter papers. Inquiries should be addressed to The James F. Lincoln Arc Welding Foundation, Cleveland, Ohio.

Washington Award to William Lamont Abbott

This year's recipient of the Washington Award—William Lamont Abbott, retired chief operating engineer of the Commonwealth Edison Company—was honored at a dinner held in Chicago on February 26. The unusually large attendance of 477 included several of the former recipients of the award and representatives of the leading engineering societies. Vice-President Charles B. Burdick represented the Society.

Founded in 1916 by John W. Alvord of Chicago, the Washington Award is administered by the Western Society of Engineers on recommendation of a commission representing the Four Founder

William Lamont Abbott

Societies and the Western Society of Engineers. Previous recipients include Herbert Hoover, Orville Wright, Michael Pupin, Ralph Modjeski, and Ralph Budd.

When Mr. Abbott retired from active service with the Commonwealth Edison

Company in 1935, he closed a distinguished utility career dating back more than half a century. Soon after coming to Chicago in 1884, he joined two associates in organizing the National Electrical Construction Company. Mr. Abbott assumed full control of this concern in 1889 and five years later sold it to the Chicago Edison Company, predecessor of the Commonwealth Edison Company, at the same time accepting a position as chief engineer of the Harrison Street Generating Station. In 1889 he was appointed chief operating engineer. From 1905 to 1923 Mr. Abbott was a trustee of the University of Illinois, his alma mater, and for most of this period was president of the board. He has served as president of both the American Society of Mechanical Engineers and the Western Society of Engineers and is a fellow of the American Institute of Electrical Engineers. He was twice awarded the Chanute Medal of the Western Society of Engineers.

The citation accompanying the present award reads "for advancing the standards of the engineering profession, for services to higher education; for aiding combustion research."

Examination for Assistant Sanitary Engineer

ANNOUNCEMENT has been made of an examination for appointment as assistant sanitary engineer in the Regular Commissioned Corps of the U.S. Public Health Service. This examination—to be held at 9 a.m. on May 11, 1942—may be taken in Washington, D.C.; Cincinnati, Ohio; New Orleans, La.; Kansas City, Mo.; and San Francisco, Calif.

Candidates must be not less than 23 years old nor more than 32 and must have had at least seven years of educational and professional training. In addition, the candidate will be required to pass a satisfactory physical, academic, and professional examination. In all, the examinations will require about seven days for completion. Those wishing to take the examination should address their applications to the Surgeon General, U.S. Public Health Service, Washington, D.C., in their own handwriting requesting permission to appear before the board of examiners.

Compensation, including allowance for quarters and subsistence, will be $3,158 and $2,699 for officers with and without dependents, respectively.

Iowa Institute to Hold Second Hydraulics Conference

ARRANGEMENTS for a Second Hydraulics Conference, to be held at Iowa City June 1–4, are now being completed by the Institute of Hydraulic Research of the University of Iowa. In view of the tremendous role played by the science of fluid motion in the present emergency, the conference will place emphasis upon those phases of hydraulic engineering which involve fundamental principles of mutual importance to other engineering professions and defense agencies of the Government. The Conference will be held under the auspices of the American Society of Civil Engineers, the American Society of Mechanical Engineers, and the Society for the Promotion of Engineering Education.

The opening session is to be devoted to two general addresses on the application of present-day knowledge of fluid motion to both hydraulic engineering and modern warfare. Aside from an afternoon demonstration of the facilities and research projects of the Institute Laboratory, the six remaining sessions of the four-day conference will be devoted to papers showing the inherent relationship of such pertinent fields as marine engineering, meteorology, conservation, and aviation to the following aspects of applied hydraulics:

(1) Modern Methods of Research—techniques of the hydraulics laboratory, the towing tank, and the wind tunnel. (2) Mechanics of Fluid Resistance—boundary roughness, form drag, percolation, wave resistance. (3) Cavitation Phenomena—hydraulic structures, turbines, pumps, ship screws. (4) Problems of Wave Motion—mechanics of gravity waves, flood waves, beach waves, gas-wave analogies. (5) Engineering Aspects of Fluid Turbulence—river hydraulics, evaporation, meteorology, density currents. (6) Sediment Transportation—bed load and suspended load in rivers, sediment characteristics, beach erosion, movement of sand by wind.

Invitations to present papers have been given to leading investigators in the several fields. Indications are that this second conference will attract as notable a gathering of engineers as did the first of this conference series held in 1939. Further details of the conference program will appear in the May issue of CIVIL ENGINEERING.

Construction Industry to Push Sale of Defense Bonds

A CAMPAIGN for more active distribution of defense savings bonds and stamps has been instituted by the United States Treasury. Increased sale of these bonds and stamps is sought so that the war into which our country has been plunged may be successfully prosecuted. This is in compliance with the Government's policy of mobilizing all national resources.

It is planned to canvass every professional and business establishment in the country, and to give every earner an opportunity to subscribe on a voluntary and systematic basis for as many bonds as each individual may be able to purchase out of his or her earnings.

To facilitate the accomplishment of this aim, an arrangement called the Payroll Savings Plan has been devised. The benefits, aside from supplying the Government with the sinews of war, are obvious—a reservoir of personal savings will be established as a cushion against possible emergencies. At the same time a brake against inflation is established in that consumer money is taken out of circulation.

A group of men representative of all phases of the construction industry have been appointed to assist the Treasury Department in the execution of this plan. The committee for the New York Metropolitan area consists of the following: Alfred Rheinstein, M. Am. Soc. C.E., chairman; Daniel Paul Higgins, vice-chairman; Thomas Crimmins, heavy construction; J. Andre Fouilhoux, M. Am. Soc. C.E., architects; Thomas A. Murray, building trades labor unions; C. G. Norman, building trades employers; and John E. Lane, professional engineers.

All employers will be called upon to signify their willingness and desire to help, and to designate some one in their organization who will work with the committee and the Treasury Department toward putting this plan into effect.

The Treasury Department, Defense Saving Staff, 1270 Sixth Avenue, New York City, will furnish any aid in the way of literature, forms, posters, speakers, etc., that may be required to set up this plan.

Federal Works Agency Report for 1941

RECENTLY issued is a 480-page book outlining the accomplishments of the Federal Works Agency for the year ending June 30, 1941. Making up this great Government construction organization are the Administrations of Public Buildings, Public Works, Public Roads, and Work Projects, as well as the U.S. Housing Authority.

Results of the expenditure of over two and one half billion dollars are covered in the report. Bridges, highways, housing projects, parkways, public buildings, airports, and other defense activities are all included. The factual presentation must be a satisfaction to the engineering staff that has carried on these tremendous activities. The report is illustrated, and about one-third of it is composed of tabulated data. It may be obtained from the Superintendent of Documents in Washington, D.C., at a cost of 65 cents.

Members Appointed to National Panel of American Arbitration Association

THE American Arbitration Association has announced the recent addition of four members of the Society to the National Panel of Arbitrators of the Association. These new appointees—Frederick H. McDonald, T. C. Forrest, Jr., J. N. Pease, and Edward H. Prentice—join a carefully selected group of educators, professional men (including a representative group of civil engineers), and business men, who are available to the Association to act as impartial arbiters when called upon.

Due to the speed with which decisions can be reached through the arbitration of commercial and industrial disputes, war industries have turned to voluntary arbitration to such an extent that the Arbitration Association, a non-profit organization, has opened its office, hearing room, and personnel facilities in thirty key cities for

the use of war industries. These cities are Albany, Atlanta, Boston, Buffalo, Charlotte, Chicago, Cincinnati, Cleveland, Dallas, Denver, Des Moines, Indianapolis, Detroit, Kansas City, Los Angeles, Memphis, Milwaukee, Minneapolis, New Haven, New Orleans, Oklahoma City, Omaha, Philadelphia, Pittsburgh, Portland, St. Louis, Salt Lake City, San Francisco, Seattle, and Washington. The national office is in New York.

Occupational Questionnaire

BUSINESS men are being called upon to help the Government list the occupational skills of all men registered under the Selective Service System. This survey is to be by the U.S. Employment Service in cooperation with the Selective Service Boards. Questionnaires will be sent by the boards to all men between the ages of 20 and 44 who registered on February 16. This will be in two parts—one for the local Selective Service Board, and one for the U.S. Employment Service. Later the same questionnaire will be sent to other registrants between the ages of 18 and 64.

One purpose is to obtain from each man a statement as to his occupation and skills. Every man is asked to check those jobs, out of 225 listed, as essential to war production in which he has had experience or training. That part of the form intended for the employment service will be sent to its nearest local office for examination to determine which men are already qualified or can be quickly trained for war production work. These men will then be asked to come to the office for an interview as to possible jobs.

Men with skills important to war production will be classified as follows:

1. Those who are now working in war industry and cannot be easily replaced.
2. Those who are now working in war industry but can be replaced within a reasonable time by vocational trainees or others not suited for military service.
3. Those who are not using those skills in war industry but can be shifted to a war industry job.

The questionnaire carries the suggestion that if the man who fills it out needs any help in answering the occupational question, he should go to his employer. Some may overlook the importance of listing their secondary skills and those they have used on other jobs.

The complete listing of the skills of the nation's man power will be of particular advantage to employers because it will help industry to retain men with special occupational ability, as well as to obtain skilled men for war production jobs.

"Engineering as a Career"

UNDER the attractive title, "Engineering as a Career," a pamphlet has just been issued by the Engineers Council for Professional Development. As its name implies and its foreword indicates, it is intended "for young men, parents, teachers, and others interested in educational guidance, to give something of an introductory insight into the profession of engineering. It is dedicated to the coming generation of engineers and to the constructive contribution that they will make to the life and culture of mankind."

In the first section, the scope of engineering is covered in a simple, brief manner. It tells the young man what engineering is, what engineers do, the various aspects of engineering work, the type of person to whom it might appeal, how he would prepare for the profession, and what it would eventually hold for him. The treatment is informative, devoid of eulogy or sales atmosphere.

Assuming that the young man is interested enough to look into the subject further, a second part gives more detailed information on the principal branches of engineering. Something over two pages is devoted to a concise description of the particular field of civil engineering, for example. The other branches, including chemical engineering, are similarly covered. The relation between the various national societies is also explained, with emphasis on the unity of the profession as a whole.

Finally, in Part 3, twenty-five references are given to books and pamphlets that will afford additional guidance, with a brief statement of content. The whole booklet of thirty-six pages may therefore be considered as presenting a sort of panorama of engineering, to be taken in at a glance. From it the prospective student may extract sufficient information to make him wish to pursue the subject further. It is written in his language. Even experienced engineers may find in it something of value, particularly as regards branches of engineering allied to their special interests.

"Engineering as a Career" is available from the Engineers' Council for Professional Development, at Society Headquarters, at a cost of ten cents a copy. Members will find that this booklet will answer many of the questions that high school students bring to engineering friends and relatives. It takes the place of "Engineering—A Career, A Culture," now out of print. The present revision has the endorsement of the E.C.P.D. and is the result of a number of years of intensive study and revision.

Edison Medal to Electrical Engineer

ANNOUNCEMENT has been made of the award of the Edison Medal for 1941 to Dr. John B. Whitehead "for his contributions to the field of electrical engineering, his pioneering and development in the field of dielectric research, and his achievements in the advance of engineering education." The Edison Medal was founded by associates and friends of the late Thomas A. Edison and is awarded annually for "meritorious achievement in electrical science, electrical engineering, or the electrical arts" by a committee consisting of twenty-four members of the American Institute of Electrical Engineers. The medal was presented to Dr. Whitehead during the winter convention of the Institute, which took place in New York January 26 to 30.

This year's recipient of the medal is a director of the school of engineering at Johns Hopkins University, where he has taught for many years. He was dean of the school of engineering from 1919 to 1938. The author of numerous papers in the field of high voltage insulation, Dr. Whitehead has been honored by numerous organizations in this country and abroad. He is a member and past-president of the American Institute of Electrical Engineers.

Iowa Engineers Are Professional-Minded

A STATEMENT of professional relations and engineering obligations has been adopted by the Iowa Engineering Society. At its 54th annual meeting in Cedar Rapids on February 12–13, the form to which the members of the Iowa Engineering Society subscribed was finally approved.

The Iowa Engineering Society

Engineer's Pledge of Service

Realizing an Engineer's obligation to his profession and his responsibility to mankind for the proper use of engineering knowledge and skill, I do solemnly pledge that to the best of my knowledge and ability, I will . . .

1. **Place service to mankind above personal gain and use my engineering knowledge and skill so that results of my efforts may benefit humanity.**
2. **Render faithful professional service to my employer and client and honestly represent his interests.**
3. **Be governed by the highest standards of integrity, fair dealing and courtesy in my relations with others.**
4. **Assist and encourage the development of the Engineering Profession and contribute to the improvement of the service of Engineering.**

The pledge of service, evidencing high professional ideals, is illustrated herewith. A place for the signature of the engineer is provided, although not shown in the illustration.

This pledge forms the front of a four-page folder, $8^1/_2$ by 11 in., on substantial paper. On the interior pages is given that society's conception of the engineer's code of ethics. It states in detail his relationship to the public, to the employer or employee, to the client, to his fellow engineers, to the contractor, and to other professions. This is one of the most advanced statements that has appeared from any group in recent years. It expresses the high idealism that should actuate the engineer in all his dealings; it details how, according to the foreword, he may be "guided in all his relations by the highest standards of integrity, fair dealing and courtesy." The Iowa Engineering Society is to be congratulated on this progressive endeavor.

Higher Working Stresses for Steel

DESIGNERS of structures can make a great contribution in conserving the available supply of critical materials by substituting less critical alternate material, or by raising working stresses in the critical material when it must be used.

Steel is needed in so many places for so many purposes in the war effort, that design agencies of the Government are using a 20,000-lb per sq in. design stress. The Construction Branch of the War Production Board recently recommended to the Defense Plant Corporation that, consistent with standard engineering design factors, and with the demand of the war effort to conserve steel, working stresses in this material of 20,000 lb per sq in. be used when the steel complies with specifications A7-39 of the American Society for Testing Materials.

To make such working stresses generally applicable will necessitate the revision of some building codes and standard specifications. Over 300 cities already permit maximum fiber stresses of 20,000 lb per sq in. in tension and bending. The Bureau of Industrial Conservation of the War Production Board has requested the American Standards Association to undertake the development of a recommendation to the Board for still higher allowable design stresses for structural steel in buildings, and to make such other recommendations with respect to the design of steel buildings as will conserve the use of steel for these purposes, consistent with factors of safety that are reasonable in the present war emergency.

Brief Notes

WORD has reached Society Headquarters of one of its younger members—Steven Malevich, Jun. Am. Soc. C.E.—who has distinguished himself with General MacArthur in the Philippines. Captain Malevich, who went to the Philippines last July as a volunteer, was in charge of an engineering crew whose work under pressure made it possible for General MacArthur's men to withdraw successfully across a bridge damaged by a Japanese bomb. After graduating from Carnegie Institute of Technology, where he was active in the R.O.T.C., Captain Malevich worked for the Jones and Laughlin Steel Corporation in Pittsburgh. Later he was with Whitman, Requardt, and Smith, of Baltimore, engaged on the construction of Edgewood Arsenal.

* * * *

THE Philadelphia Section is cooperating with the Portland Cement Association in sponsoring a series of lectures on modern developments in concrete design and construction. On Tuesday, April 14, the talk is by Byron Hunicke on "Concrete Construction Methods"; on April 28, by Stanton Walker, M. Am. Soc. C.E., on the "Design of Concrete Mixes"; and on May 12 by A. J. Boase, M. Am. Soc. C.E. on "Recent Outstanding Examples of Concrete Construction." The April lectures are at 8 p.m. in Drexel Auditorium, and the May meeting at 7:30 p.m. at the Engineers Club in Philadelphia. All members of the Society and their friends are invited.

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PROCEEDINGS of the twenty-second annual meeting of the National Council of State Boards of Engineering Examiners—held in New York City in October 1941—are now available in published form in conjunction with the 1942 year book of the Council. The volume sells for $2 and may be obtained from headquarters of the National Council of State Boards of Engineering Examiners, 503 Carolina Life Building, Columbia, S.C.

* * * *

SEVERAL members of the Society have been honored by the American Water Works Association. The roster of 1942 officers includes Abel Wolman, president; Samuel B. Morris, vice-president; and William W. Brush, treasurer (reelected). The new honorary members—James M. Caird, William E. Vest, and W. W. DeBerard—are also members of the Society, as are the Diven Medalist (Samuel F. Newkirk, Jr.) and the Goodell Prize winner (R. F. Goudey).

Engineers in Congress

IT IS a well-known fact that engineers are not prominent in the field of politics or statescraft. This fact was emphasized in a study of the professions of Congressmen recently brought to our attention. The tabulation below speaks for itself.

The first column in each case gives what seems to be the principal classification, the second column what might be called a former or secondary classification.

CLASSIFICATION OF SENATORS AND REPRESENTATIVES

Compiled from Congressional Directory (1942) and *Who's Who in America*

	Senators		Representatives	
	Principal	Former	Principal	Former
Lawyers	57	6	253	12
Miscellaneous Business	9	3	41	13
Farmers	7	6	27	15
Editors, Publishers, etc.	9	2	25	11
Insurance, Real Estate	2	..	25	4
Professors, Teachers	3	2	14	34
Public Office	4	7	12	18
Doctors, Dentists, etc.	2	..	12	..
Investments, Banking	1	4	9	13
Not classified	1	..	9	..
Engineers		2	5	4
Vacancies	1	..	3	..
Total	96		435	

THE American Standards Association has announced the publication of its new list of American Standards for 1942. Nearly 500 American standards are listed in a wide variety of industrial fields and in the fields of industrial and public safety. There is a separate heading for American Defense Emergency Standards, and for the first time all American Safety Standards are listed together in a separate section. These standards include definitions of technical terms, specifications for metals and other materials, methods of test for the finished product, dimensions, safety provisions for the use of machinery, and methods of work. The list will be sent free to anyone asking for it, and requests should be addressed to the American Standards Association, 29 West 39th Street, New York, N.Y.

NEWS OF ENGINEERS

Personal Item About Society Members

ADDITIONAL changes in the status of members of the Society in the Officers Reserve Corps of the Army and in the U.S. Naval Reserve include Lt. Col. Rufus W. Putnam, from president of the Maritime Engineering Corporation, Chicago, Ill., to active duty in the office of the U.S. Division Engineer, Great Lakes Division, Cleveland, Ohio; Lt. (jg) Joseph B. Diamond, from attorney-at-law, New York, N.Y., to active duty at the Boston (Mass.) Navy Yard; Ensign Roger H. Gilman, from statistician for the Port of New York Authority, to the Naval Training School at Fort Schuyler; and Ensign Julian Kheel, from designer for the Bureau of Ships, Navy Department, Washington, D.C., to the Civil Engineer Corps of the U.S. Navy, stationed at Mechanicsburg, Pa.

MEMBERS of the Society in the Civil Engineer Corps of the U.S. Navy who have received temporary promotion from the rank of commander to captain include Carl H. Cotter, Hugo C. Fischer, and Raymond V. Miller. On the list of promotions from lieutenant commander to commander there are George Reitzle Brooks, Charles T. Dickeman, John J. Gromfine, and Fritz C. Nyland. Members in the Reserve Corps promoted from the rank of lieutenant commander to commander include Carl E. Beam, Gilbert A. Hunt, John S. Leister, Albert A. Ort, and Emil Praeger.

CLIFFORD A. HAHN, in charge of engineering for the H. J. Heinz Company, of Pittsburgh, Pa., has been granted a leave of absence in order to serve the government in the capacity of administrative consultant. He will be located in Washington, D.C.

WILLIAM VON PHUL is retiring from the presidency of Ford, Bacon and Davis, New York, N.Y., after serving in that capacity since 1922. Mr. von Phul will actively continue as chairman of the executive committee.

IVAN C. CRAWFORD, JR., formerly instructor in civil engineering at the Mis-

souri School of Mines, has been made assistant professor of civil engineering at Rhode Island State College.

ABRAHAM SAMUEL NEIMAN recently resigned as assistant highway engineer for the Illinois State Division of Highways in order to accept a position as structural engineer for the U.S. Maritime Commission, with headquarters in Washington, D.C. His work consists of the design and approval of plans for concrete ships.

ARTHUR GEORGE SCHWARTZENHAUER is now plant engineer at the aggregate and batching plant at the Naval Operating Base at Honolulu, Hawaii. Mr. Schwartzenhauer recently spent a number of months on design and construction work on the Island of Wake, barely missing the "blitz."

T. C. FORREST, JR., Dallas (Tex.) consultant, has been named resident engineer at Denison, Tex., in charge of a survey to be made in connection with the construction of a large army camp there. His corps of assistants will include L. D. MATTER, who will serve in the capacity of water and sewer engineer.

GEORGE E. HARKNESS has retired as bridge engineer in the Massachusetts Department of Public Works after a number of years of service.

J. S. GENA, who has been serving as assistant chief engineer of the Muskingum Watershed Conservancy District at New Philadelphia, Ohio, has been appointed engineer for the War Products Cooperative, a manufacturers' organization in nine counties in the New Philadelphia area.

EUGENE QUIRICONI, formerly structural draftsman in the Bureau of Highways, Borough of Queens, New York, has accepted a position as designing engineer for the Ferber Company—engineers and builders—of Hackensack, N.J.

CHARLES H. CAPEN, engineer for the North Jersey District Water Supply Commission, was recently appointed chief engineer and administrative head of that body. He is the first to hold the title of chief engineer since the Wanaque water system—which supplies eight communities in northern New Jersey—was completed eleven years ago.

MYRON W. TATLOCK has been granted a six-month leave of absence from his duties as superintendent of sewage treatment for the city of Dayton, Ohio, in order to become assistant chief engineer for the Charles H. Hurd Company on the construction of a large army camp near Indianapolis, Ind.

GEORGE W. MCCORDIC was recently appointed engineer-director of the Huron-Clinton Metropolitan Authority, with headquarters in the Penobscot Building, Detroit, Mich. He was formerly manager of the Port of Detroit Commission, Detroit, Mich.

OREN REED, who is on the staff of the Tennessee Valley Authority, has been appointed construction engineer on the Fontana Dam project, with headquarters in Knoxville, Tenn. Until lately he served in a similar capacity on the construction of the Watts Bar Dam.

ROBERT E. CRAWFORD has resigned as assistant engineer of bridges for the Southern Railway at Knoxville, Tenn., in order to become connected with the consulting firm of Fay, Spofford and Thorndike, of Boston, Mass.

ROLF T. RETZ, for the past seven years an associate specification engineer on the staff of the TVA at Knoxville, Tenn., has been transferred to the U.S. Engineer Office at Jacksonville, Fla., as civil engineer in the Defense Design Division.

HENRY F. STUBBS, who is on the staff of the Ambursen Engineering Corporation, has been temporarily assigned by that organization as supervising engineer on the Brighton Dam, in Maryland, for the Washington Suburban Sanitary Commission. Mr. Stubbs recently served as acting project engineer for the Ambursen Corporation at Mineral Wells, Tex.

JAMES BURNHAM ROBINSON, lieutenant, U.S. Naval Reserve, was captured on Wake Island by the Japanese shortly before Christmas. Before going to Wake Island Lieutenant Robinson was stationed at the U.S. Navy Yard at Pearl Harbor, Hawaii.

SOCIETY members at the Utah Ordnance Plant include Maj. David E. Donley, who is serving as executive officer for the Ordnance Department of the U.S. Army; M. R. Warden, works manager for the Remington Arms Company, Inc.; and F. M. Hines, project manager for Broderick and Gordon, principal constructor. The following are representatives of Smith, Hinchman and Grylls, Inc., and R. J. Tipton, Architect-Engineer: R. G. Harding, office engineer; G. M. Haley, chief field engineer; R. A. Hart, office manager; J. H. P. Fisk, assistant engineer in charge of water-works design; J. H. Sanford, assistant engineer in charge of plant layout; and D. O. Runyan, engineering designer of power plant and machine layout.

SAMUEL SHULITS is now a hydraulic engineer in the U.S. Engineer Office at Charleston, S.C. Until recently he was chief of the Engineer Department Research Centers, of the U.S. Waterways Experiment Station at Vicksburg, Miss.

FRANK L. FLOOD has been admitted to the engineering firm of Metcalf and Eddy, of Boston, Mass. Mr. Flood has been with Metcalf and Eddy since 1925—first as assistant engineer and, later, as senior assistant engineer.

CLAYTON W. PAIGE is now city engineer of Burbank, Calif. For the past nine years he has served the city of Alhambra, Calif., in a similar capacity.

GERALD M. RIDENOUR, formerly associate professor of sanitary engineering at Pennsylvania State College, has assumed new duties as associate resident lecturer in public health engineering in the School of Public Health at the University of Michigan.

ISAAC HARBY has accepted a position as supervising engineer for the Defense Plant Corporation, his work being in connection with the supervision of the expenditure of the loans made to defense industries by the Reconstruction Finance Corporation. His headquarters are in Buffalo, N.Y.

FRANK C. STURGES has been promoted from the position of general manager for the Pennsylvania Drilling Company, Pittsburgh, Pa., to that of vice-president. JOHN H. MELVIN, formerly geologist for the organization, has been elected treasurer.

JAMES I. BALLARD, for the past year managing editor of *Engineering News-Record*, has taken up new duties as assistant to the publisher of *Engineering News-Record* and *Construction Methods*. The managing editorship has been assumed by EDWARD J. CLEARY, formerly associate editor.

J. E. WILLOUGHBY, previously chief engineer of the Atlantic Coast Line Railroad, has been appointed to the post of consulting engineer. His headquarters will be changed from Wilmington, N.C., to Blount Springs, Ala.

WILLIAM HENRY HAMILTON has returned to employment in the Denver office of the U.S. Bureau of Reclamation after a period of affiliation with the Federal Power Commission in the capacity of engineer.

FRANK H. SHAW is now in charge of defense plants in Utah for the Defense Plant Corporation, and has headquarters in the Field Building, Chicago. Mr. Shaw was previously supervising engineer for the Reconstruction Finance Corporation at Dallas, Tex.

DECEASED

FRED WALTER ABBOTT (M. '04) chief engineer for the Publicker Commercial Alcohol Company, of Philadelphia, Pa., died on February 28, 1942. He was about 70. Mr. Abbott, who had been with the Publicker Company since 1936, was for many years a member of the Philadelphia firm, Sax and Abbott. His firm designed and superintended the construction of structural steel work and foundations for many buildings in Philadelphia and other cities.

EARL CURTIS ALEXANDER (Assoc. M. '22) chief engineer for the Massey Concrete Products Company, of Chicago, Ill., was fatally stricken in his office on February 9, 1942. Mr. Alexander, who was 59, had been with the Massey Concrete Products Company in varying capacities since 1918. His early career included work with the Philippine Railway Company, the Illinois Central Railway, and the Northern Pacific.

JOHN EDWIN BANKS (M. '17) retired engineer of Ambridge, Pa., died recently at the age of 74. Mr. Banks was with the American Bridge Company from 1902 until his retirement in 1935—for much of this period as assistant engineer. Earlier in his career he had taught at Cornell University and in the Anglo-Chinese School at Singapore, and for six years (1894 to 1900) was with the Pittsburgh Bridge Company.

REGINALD PELHAM BOLTON (M. '99) president and chairman of the board of the Electric Meter Corporation, New York, N.Y., died in that city in February. He was 85. A native of England, Mr. Bolton was apprenticed to an engineering firm in Lambeth, coming to this country at the age of 23. Since establishing himself in New York in 1894, he had served as consultant to the Department of Water Supply and to R. H. Macy and Company, and on the construction of the Grand Central Terminal. Deeply interested in American history, he was noted for his books on early New York.

JOHN WILLIAM FERGUSON (M. '87) president of the John W. Ferguson Company, building contractors and engineers of Paterson, N.J., died at his home in that city on February 4, 1942. Mr. Ferguson, who was 81, was at one time president and chairman of the board of the Manufacturers' Association of New Jersey.

JOHN FARNSWORTH HAMMOND (M. '06) of Hollis, N.Y., died there on February 22, 1942, at the age of 75. Until his retirement a few years ago Mr. Hammond maintained a consulting practice at Hollis. Prior to that he had consulting offices at Richmond Hill, N.Y., and at one time was president of the engineering and contracting firm of Hammond and Sloane, Inc., of New York, N.Y. Earlier in his career (1889 to 1895) he was assistant engineer in the Brooklyn Department of City Works, and from the latter year to 1905 he held a similar position in the New York City Department of Sewers.

JOSEPH JACOBS (M. '09) for many years consulting engineer in the Pacific Northwest and an authority on matters connected with the study and use of water, died in Seattle, Wash., on March 16, 1942. Mr. Jacobs served as Director of the Society from 1929 to 1931 and as Vice-President in 1940 and 1941. A photograph and more detailed account appear in the Society Affairs department of this issue.

WILLIAM LOUIS KUEHNLE (Assoc. M. '11) principal engineer in the U.S. Engineer Office at Tulsa, Okla., died at Watonga, Okla., on February 7, 1942, from injuries received in an automobile accident a few hours earlier. He was 60. Except for a brief period in private practice and four years (1927 to 1931) as chief engineer of the Dry Ice Corporation of America, Mr. Kuehnle had been in the U.S. Engineer Office since 1902. He had been located at Binghamton, N.Y., and Mineral Wells, Tex., and was senior engineer at Little Rock, Ark., prior to the opening of the district office at Tulsa in 1939.

JAMES BELL LEIGH (Assoc. M. '23) of Pottsville, Pa., died on February 16, 1942, at the age of 49. Mr. Leigh spent a number of years with the Arkansas State Highway Department, having been assistant engineer and construction engineer. During the war he served overseas—first in the 43d Bridge and Highway Battalion and, later, with the 20th Engineers.

CLARE SLOAN MCARDLE (Assoc. M. '24) since 1935 vice-president and sales manager for the Missouri Portland Cement Company, St. Louis, Mo., died on January 2, 1942. He was 49. From 1914 to 1917 and from 1919 to 1923 Mr. McArdle was with the Illinois State Highway Department—part of the time as general superintendent of construction. From 1923 to 1926 he held a similar position with the Moreno Burkham Construction Company, and from 1927 to 1935 was with the Atlas and Universal Atlas Cement Company. During the war he served with the Corps of Engineers, U.S. Army.

ERNEST MCCULLOH (M. '03) of Minneapolis, Minn., died on February 16, 1942, at the age of 75. Mr. McCulloh's early career included experience with the U.S. Reclamation Service in Washington and other Western states and some years as a consultant. In 1917 he went to Minneapolis to join the Charles L. Pillsbury Company (now the Pillsbury Engineering Company), remaining with this organization until 1926. Later he served as consultant for the C.A.P. Turner Company, the U.S. Indian Service, and other firms and organizations.

WILLARD AVERELL POLLARD, JR. (Assoc. M. '21) Commander, Civil Engineer Corps, U.S. Navy, died at his home in Washington, D.C., on February 20, 1942. Commander Pollard, who was 46, was retired from active duty after his return from an assignment in Panama because of illness. Commander Pollard served in the Navy in the first World War, finally attaining the rank of commander. Since then he had served at the Bureau of Yards and Docks in Washington, the Naval Operating Base at Norfolk, Va., and the U.S. Naval Station in the Virgin Islands (where he was Public Works Officer).

GEORGE WILLIAM REAR (M. '23) engineer of bridges for the Southern Pacific Company, San Francisco, Calif., died on February 10, 1942, at the age of 68. Born and educated in Canada, Mr. Rear spent his early career in railroad work there. He had been with the Southern Pacific since 1901—as general bridge inspector from 1905 to 1922, and engineer of bridges since the latter date.

AUGUST ZIESING (M. '98) retired president of the American Bridge Company, died at his home in Glencoe, Ill., on February 16, 1942. Had he lived a few days longer he would have been 84. Mr. Ziesing's early career included work with the Pennsylvania Railroad and the Lassig Bridge and Iron Works (1883 to 1895). When the American Bridge Company was formed he was appointed Western manager, and in 1905 was elected president—a post he held until his retirement in 1927. Many notable New York structures, including two East River bridges, were built under his supervision.

Changes in Membership Grades

Additions, Transfers, Reinstatements, and Resignations

From February 10 to March 9, 1942, Inclusive

ADDITIONS TO MEMBERSHIP

BAIRD, JOSEPH HENRY (M.'42), Asst. Chf. Engr., Giffels & Vallet, Inc., Naval Operating Base (Res., 157 Wells Parkway), Norfolk, Va.

BELL, JOHN WRIGHT (Jun. '41), Lt., 69th Ordnance Company, U.S. Army, Fort Jackson, S.C. (Res., 3241 A St., Hayward, Calif.)

BODWELL, GEORGE BISHOP (Jun. '41), Mgr., Contract Dept., The Philip Carey Mfg. Co., 5906 Euclid Ave., Cleveland, Ohio.

BROWN, KENNETH ROOSEVELT (Jun. '41), Draftsman, Am. Bridge Co., Elmira Heights (Res., 465 West Church St., Elmira), N.Y.

BROWN, LEROY ALEXANDER (Jun. '42), With The Texas Co., 205 West 42d St. (Res., 616 West 116th St.), New York, N.Y.

BRUNKOW, NORMAN FERDINAND (M. '42), Structural Engr., Greeley & Hansen, 6 North Michigan Ave., Chicago, Ill. (Res., 316 Fairfax Ave., Norfolk, Va.)

BRUNSMA, HERBERT (Assoc. M. '42), Office Engr., Design, State Highway Comm., State House Annex, Indianapolis (Res., 1009 Main St., Beech Grove), Mo.

BUTLER, CHARLES MATHEWS (Assoc. M. '42), Asst. Engr., U.S. Engr. Dept., Box 500, Lake Charles, La.

CARRAN, WALTER EDWARD, JR. (Jun. '41), With Special Eng. Div., The Panama Canal, Diablo Heights, Canal Zone.

CHASE, FRANCIS MICHAEL (Jun. '41), 480 Sherman St., Canton, Mass.

CHESTER, ISRAEL (Jun. '42), Tutor, Drafting, The City College School of Technology, 139th St. and Convent Ave., New York (Res., 199 Dahlgren Pl., Brooklyn), N.Y.

CLARK, GEORGE EDWARD (Assoc. M. '41), Chf., Repair and Const. Div., Interior Dept., National Capital Parks, 18th and C Sts., N.W. (Res., 3301 Porter St., N.W.), Washington, D.C.

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